# Popular Astronomy.

Vol. XXVIII, No. 8 OCTOBER, 1920. Whole No. 278

## TWENTY-FOURTH MEETING OF THE AMERICAN ASTRONOMICAL SOCIETY.

The twenty-fourth meeting of the Society was held on September 1 to 4, 1920 at Smith College, Northampton, and Mount Holyoke College, South Hadley, Massachusetts, on the joint invitation of the directors of the observatories, Miss Harriet W. Bigelow and Miss Anne S. Young. The headquarters for the meeting was the Gillett House, at Northampton, one of the residence halls, where the members and friends were comfortably located, and for four days enjoyed the pleasure of what amounted to a large house party in the delightful surroundings of the college. This was the first occasion on which the Society had met regularly at a woman's college, and it was a double pleasure to visit two such institutions, and especially to find in what flourishing condition are their observatories and astronomical departments. Visiting astronomers from large observatories were much interested in the conveniences for the instruction of students, and it was agreed that the teaching of astronomy is certainly flourishing in colleges for women.

The sessions at Smith were held in the lecture room of Burton Hall, not far from the Observatory. After a few preliminaries in the opening session, the reading of papers was started in earnest, and on the first day the strenuous program was well advanced. Because of the pressure of time, it was necessary to make a limit of one paper per individual, and members generally over the country took the hint and sent or presented short communications. It was gratifying to note the increase in the tendency of the members to present concise statements of their work, which encouraged extemporaneous discussion.

At the close of the afternoon meeting adjournment was taken to the lawn near the Observatory where the members underwent the annual ordeal of the group photograph, followed by tea and a social hour amid the beautiful surroundings. At the evening reception in the Art Gallery the members had opportunity to meet some of the authorities and members of the faculty of Smith College, and to inspect the collections in the building.

On the second day the Society made the pilgrimage to Mount Holyoke. A special trolley car carried the party through Holyoke City and past Mount Tom to South Hadley, where on arrival the members were rushed to the lecture room in one of the buildings

so that the scientific program could be carried on before the pleasure of getting acquainted with the college campus might be undertaken. The Society was the guest of Mount Holyoke College for luncheon, and it was a privilege for the members to be welcomed in person by the president, Miss Mary E. Woolley, who told of the peculiar association the institution has had with astronomy, especially through the late Professor Charles A. Young, who formerly gave courses of lectures at Mount Holyoke, and whose inspiration and work is continued by his niece, Miss Anne S. Young, the present director of the Observatory. In the afternoon the meeting adjourned in time for a pleasant hour at the Observatory with opportunity for inspection of other buildings. Returning to Northampton by way of Holyoke Notch and Amherst, we were further impressed by the scenic location of the colleges in the Connecticut Valley.

On Friday there were two more sessions for papers, the chief feature being a discussion of the astronomical aspects of relativity, lead by Dr. Ludwik Silberstein who has recently come from England to take up his abode in this country. Members and friends found time for short excursions to Old Deerfield and the summit of Mount Tom. In the evening there were various exhibits at the conversazione, in particular President Schlesinger showed lantern illustrations forwarded by Dr. Hale from Mount Wilson showing the performance of the 100-inch Hooker telescope. The Society sent a message of congratulation to Dr. Hale and his staff on the success of this great instrument.

Early Saturday morning members began to catch trains, but there was a good attendance at the final session when committee reports were read and the last papers were presented, including the very latest reports of the new star in Cygnus which were prepared at the Dominion and Yerkes Observatories.

No account of the meeting would be complete without reference to the perfect weather which prevailed throughout, and which seemed to be merely a part of the arrangements, so complete in every detail, provided by our hostesses.

There were various matters of interest in connection with committee reports. Senor Joaquin Gallo, director of the Tacubaya Observatory, Mexico, was present at the meeting and gave an account of the elaborate preparations he is making to secure the best meteorological and other data which will be used for the location of stations for observation of the total solar eclipse of September 10, 1923.

The name of the Committee on Variable Star Observations was changed to the Committee on Variable Stars, as it seemed that the old name had a tendency to limit the activities of this committee. By a vote of the Society, the committee was authorized to go ahead with a canvass to determine which of the idle telescopes in the country may possibly be brought into use, and also to act as a clearing house for

information in regard to what variable stars are on the programs of different observers and institutions.

According to the constitution, the Society may elect one honorary member at each annual meeting. On due nomination the Council elected to honorary membership

Sir Frank Watson Dyson, Astronomer Royal, Greenwich.

The Society used for the first time the new scheme for the election of officers, and was spared much of the time and effort which formerly was spent in what often amounted to a re-election of the same persons to office. Ballots had been distributed by mail with the official nominations presented by the Nominating Committee consisting of Messrs. F. C. Jordan, J. M. Poor, and E. D. Roe, and a combined count was taken of votes cast by mail and in person. The result of the election was as follows:

| | | |
|---|---|---|
| Vice-President | 1920-1922 | Otto Klotz |
| Treasurer | 1920-1921 | Benjamin Boss |
| Councilors | 1920-1923 | Caroline E. Furness |
| | | John A. Miller |

Officers continuing to serve are:

| | | |
|---|---|---|
| President | 1919-1922 | Frank Schlesinger |
| Vice-President | 1919-1921 | Walter S. Adams |
| Secretary | 1918-1921 | Joel Stebbins |
| Councilors | 1919-1921 | S. I. Bailey |
| | | W. J. Hussey |
| | 1919-1922 | H. N. Russell |
| | | V. M. Slipher |

A matter of general interest to the Society is its representation on the National Research Council. When the Research Council was re-organized in 1919, the Council of the Society nominated Messrs. H. N. Russell, W. W. Campbell, and Joel Stebbins to serve for one, two, and three years respectively as representatives on the Division of Physical Sciences. Since then Messrs. Russell and Campbell have been renominated to succeed themselves for full three-year terms, and henceforth there will be one new member each year who, by action of the Council, will be elected in the same manner as the regular officers of the Society. In accordance with the policy of the Research Council, members of the Division are ineligible for immediate re-election after serving the full term of three years.

Closely allied to the Research Council is the American Section of the International Astronomical Union which will be brought together shortly before each triennial meeting of the international organization. The Research Council has approved the statutes of the American Section which provide for an Executive Committee which will manage the affairs of the Section between meetings. This committee consists of the three astronomical members of the Division of Physical Sciences, together with the president and secretary of the American

Astronomical Society, with provision for election of another member in case either the president or secretary of the Society happens to be also a member of the Division. In accordance with this last clause, the Society elected W. S. Eichelberger as a fifth member of the committee. The organization of the Executive Committee of the American Section of the International Astronomical Union is then at present:

W. W. Campbell, *Chairman*
W. S. Eichelberger
H. N. Russell
Frank Schlesinger
Joel Stebbins, *Secretary*

It is evident that the Society will, through its elected representatives, have virtual control of the American participation in the International Astronomical Union. The next meeting of the Union has been set for 1922.

New members of the Society were elected by the Council at the meeting and during the year as follows:

Weld Arnold, Student's Astronomical Laboratory, Cambridge, Mass.
Jennie V. France, 377 Lenox Street, New Haven, Conn.
Joaquin Gallo, Observatorio Astronomico, Tacubaya, Mexico.
William Henry, 547 East 4th Street, Brooklyn, N. Y.
Wm. H. Keeble, Randolph-Macon College, Ashland, Va.
Harold Reynolds Kingston, Department of Astronomy, University of Manitoba, Winnipeg, Manitoba.
Beatrice M. Maybery, Mt. Wilson Observatory, Pasadena, Cal.
Jason John Nassau, Mathematics Department, Syracuse University, Syracuse, N. Y.
Margaret E. Powell, Sproul Observatory, Swarthmore, Pa.
H. M. Randall, Physics Department, University of Michigan, Ann Arbor, Mich.
Ludwik Silberstein, Research Laboratory, Kodak Park, Rochester, N. Y.
Julius F. Stone, Seagrave Company, Columbus, Ohio.
Lloyd Ritchie Wylie, Dearborn Observatory, Evanston, Ill.
J. Ernest G. Yalden, 120 Woodbridge Place, Leonia, N. J.
Jessica May Young, 4511 N. 20th Street, St. Louis, Mo.

The attendance at the meeting was the largest in the history of the Society, more than seventy members being present, and the other visitors brought the total up to something more than one hundred The members present were:

Sebastian Albrecht
Harold L. Alden
Leah B. Allen
Weld Arnold
S. I. Bailey
S. G. Barton
Louis Bell
Harriet W. Bigelow
Dorothy W. Block
E. W. Brown
Leon Campbell
Annie J. Cannon
R. E. DeLury
Louis Derr
A. E. Douglass
R. S. Dugan
W. S. Eichelberger
Alice H. Farnsworth
Philip Fox
Jennie V. France
Caroline E. Furness
Joaquin Gallo
A. Estelle Glancy
W. K. Green
Vera M. Gushee
J. C. Hammond
Margaret Harwood
J. P. Henderson
F. Henroteau
William Henry
Mary M. Hopkins
C. S. Howe
W. J. Hussey
F. C. Jordan
C. E. Kelley
E. S. King

| | | |
|---|---|---|
| H. R. Kingston | G. H. Peters | Joel Stebbins |
| Otto Klotz | J. M. Poor | H. T. Stetson |
| F. B. Littell | Harry Raymond | Julius F. Stone |
| H. C. Lord | Susan Raymond | Helen M. Swartz |
| E. S. Manson | E. D. Roe, Jr. | John Tatlock |
| Antonia C. Maury | F. E. Ross | S. D. Townley |
| John A. Miller | A. J. Roy | A. B. Turner |
| S. A. Mitchell | H. N. Russell | W. R. Warner |
| W. T. Olcott | Frank Schlesinger | Sarah F. Whiting |
| Margaretta Palmer | G. P. Serviss | Evelyn W. Wickham |
| H. M. Paul | Ludwik Silberstein | R. E. Wilson |
| Jesse Pawling | Frederick Slocum | Anne S. Young |

At the final session the following resolutions, introduced by Dr. Klotz, were adopted:

> *Resolved*, That the American Astronomical Society desires to express its appreciation to Smith College for its invitation to the Society for holding the annual meeting at the College; and also for the hospitality and the many kindnesses and courtesies extended to the members and guests.
>
> To Miss Bigelow, director of the observatory, and her staff more particularly thanks are due for the excellent arrangements that were made, so that our sojourn amongst the charming surroundings was one of continued delight.
>
> *Resolved*, That the American Astronomical Society desires to record its appreciation to Mount Holyoke College and its President, Miss Mary E. Woolley, for the invitation to spend a day of the meeting of the Society at the College, and for the delightful entertainment offered.
>
> To Miss Anne S. Young, director of the observatory, and her staff, our thanks are due for their indefatigable efforts to make our visit so interesting and memorable.

The Council voted that the next meeting of the Society should be in connection with the large quadrennial meeting of the American Association for the Advancement of Science in Chicago in December, 1920. There will also be a meeting of the Society in the summer of 1921, but the time and place have not yet been decided.

(*To be continued.*)

## THE ORTHOGRAPHIC PROJECTION OF A SPHERE.

By WILLIAM H. PICKERING.

Orthographic projections with the axis perpendicular to the line of sight can now be purchased ready made, but if we wish the axis inclined, there is then no resource but to make the drawing oneself. The usual method of construction is to compute all the intersections, and then draw the parallels and the meridians with the aid of draughtsman's celluoid curves. While the computations are simple, they require a good deal of time, and it is very difficult to find curves suitable for drawing ellipses of small eccentricity.

Having had occasion to make such a projection, it occured to the writer that it would be much simpler and quicker to draw the ellipses by the three-needle method, and at the same time the time of computation would be very greatly reduced. The three-needle method has been already described in detail in POPULAR ASTRONOMY 1908, **16**, 147, and in Harvard Annals **61**, 339, so that only a brief reference to it is necessary here.

The difficulty in drawing an ellipse by the ordinary method of two needles and a silk thread is twofold, *(a)* to get the thread of the proper length to fit the desired major axis, and *(b)* to keep it so, owing to the stretching of the thread. These difficulties are avoided by tying the thread in a loop, and stretching the unused side of it by means of a third needle, which may conveniently be fitted with a wooden head the size of a large pea.

Having decided on the proper inclination of the axis of the sphere, the minor axes of the various parallels and their distances from the center of the sphere were computed. The eccentricity of the ellipses was determined by the customary formula

$$e = (1 - b^2/a^2)^{1/2}.$$

The sphere was laid out with a radius of 10 centimeters, so as to avoid all constants, and the central meridian and major axis of the equator drawn. The meridian of 90° was so near a circle that it was put in with the dividers, thus at the same time locating the visible pole. The various parallels were then inserted by means of the thread.

The only real difficulty that presented itself was to determine the inclinations of the major axes of the ellipses which represented the various meridians. These inclinations could of course be computed, but as the object of the method was to save all computations as far as possible, and particularly to save time, the inclinations were solved graphically. In order to do this, a second circle like the first was drawn, but only one ellipse, that of the equator, was projected upon it.

The major axes of a number of proposed meridional ellipses were then laid down, inclined to the central meridian at angles of 5°, 10°, 15°, 20°, and 30°. Let $O\,M$, Figure 1, be one of these lines. A perpendicular $P\,M$ was dropped on it from the pole $P$. Another perpendicular was drawn at $O$. Then we have $A\,M : P\,M = C\,O : B\,O$, which together with measures of $P\,M$ and $O\,M$, or $A\,M$, the former a little more accurate, gives us the minor axis of the required ellipse. From this the eccentricity and corresponding location of the foci are obtained. The ellipse was drawn and the longitude at which it cut the equator at $E$ determined. Plotting the varying inclinations $P\,O\,M$ as ordinates, and the corresponding longitudes as abscissas, we obtained a curve showing what inclination was required for any desired longitude.

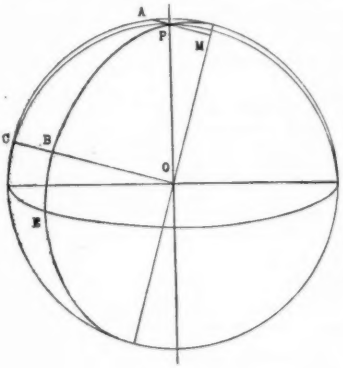


Fig. 1

Returning to the original figure, the intersections of all the meridians with the equator, and with the smallest of the latitude circles were marked. The major axes of the ellipses required for longitude were then inserted, their minor axes and eccentricities computed, and the ellipses drawn as in the graphical solution, except that in this case the perpendicular was dropped not from the pole, but from the required intersection with the equator.

In practice it was found that for the larger ellipses, whose eccentricity, was as high as that of the latitude circles, that owing to the great tension on the thread in those portions midway between the foci, a somewhat irregular line was drawn. This portion was therefore smoothed out later by means of the draughtsman's curves. The intersections with each parallel of the meridians of 10° and 20° were also computed, and inserted with the curves. The meridians of 80° and 100° were so nearly circles that they were inserted with the dividers, a radius slightly greater than that of the sphere being used, and the centers being found by trial.

In general the three-needle method of drawing ellipses is best suited to those whose eccentricity lies between 0.40 and 0.95. These correspond to minor axes of 0.91 and 0.28. When the minor axis exceeds 0.91 it is less trouble, and sufficiently accurate, to draw an oval by the well known method with dividers. When the minor axis is less than 0.28 the coördinates of the intersections had best be computed, and the ellipse inserted with the draughtsman's curves, which are well suited for this purpose. It is true that by using fine wire instead of silk thread, very eccentric ellipses may be drawn, but the coördinate

method would undoubtedly give more accurate results. The actual time required to draw the sphere in pencil by this method, with all its intersecting parallels and meridians 10° apart, was one working day. The time of computation, after the method had once been devised was considerably less than this.

Mandeville, Jamaica, B. W. I., May 14, 1920.

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**VEGA AT THE ZENITH.**

The suns of night are shining bright,
Like jewels overhead,
Arcturus gleams with golden beams,
Antares glitters red,
Altair glows white like beacon's light
Where glimmers dim Alshain,
And in the west, o'er hillock's crest,
Fair Spica sets again.

At zenith-height, with gorgeous light,
Queen Vega crowns the sky,
Like diadem, like sapphire gem,
Resplendent to the eye,
Her azure fire amid the Lyre
Is brilliantly ablaze
Where sparkle nigh, like emblem high,
The Northern Cross's rays.

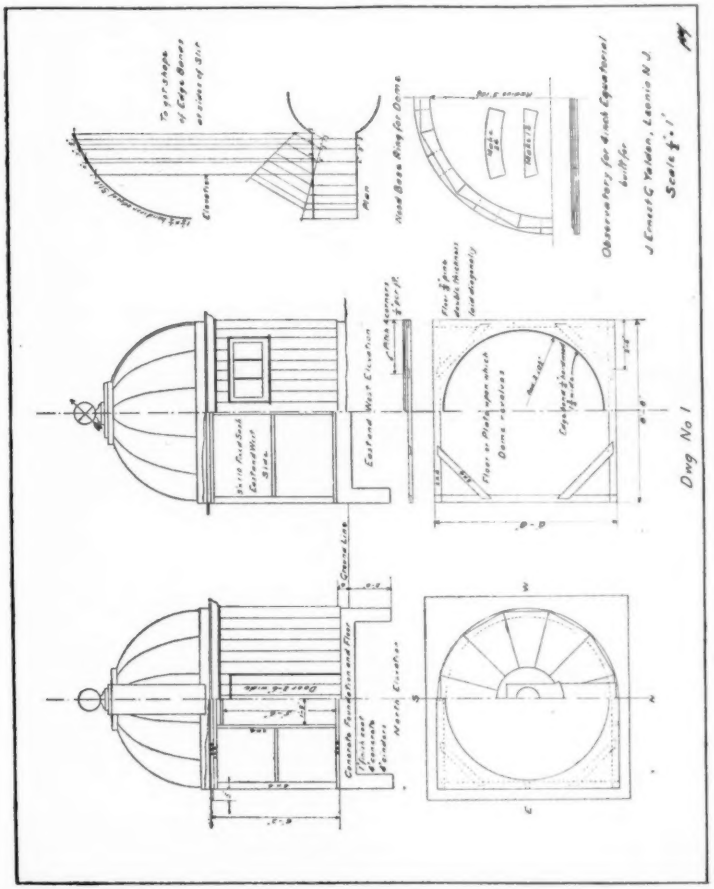
O splendid star, which shines afar
Upon us dwelling here,
That beautifies our summer skies—
Our northern hemisphere,
Whose azure rays in future days
Shall shine as clear and bright,
When she shall be, on land and sea,
The North Star of the night!

CHARLES NEVERS HOLMES.
41 Arlington St., Newton, Mass.

# THE DESIGN AND CONSTRUCTION OF A SMALL OBSERVATORY.

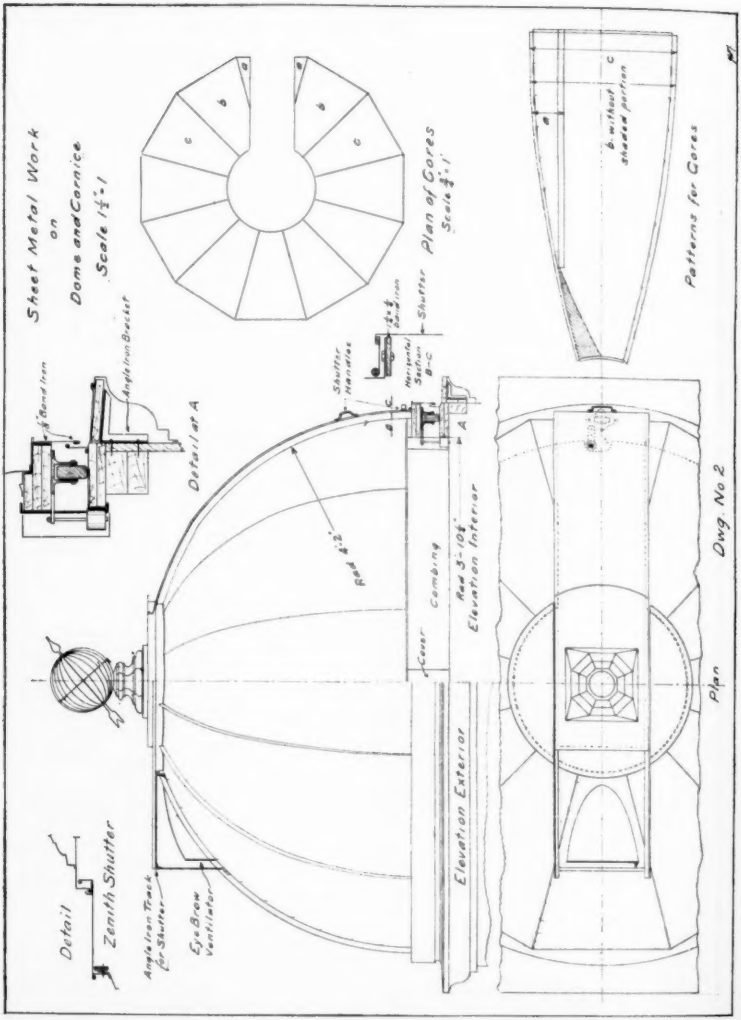
By J. ERNEST G. YALDEN.

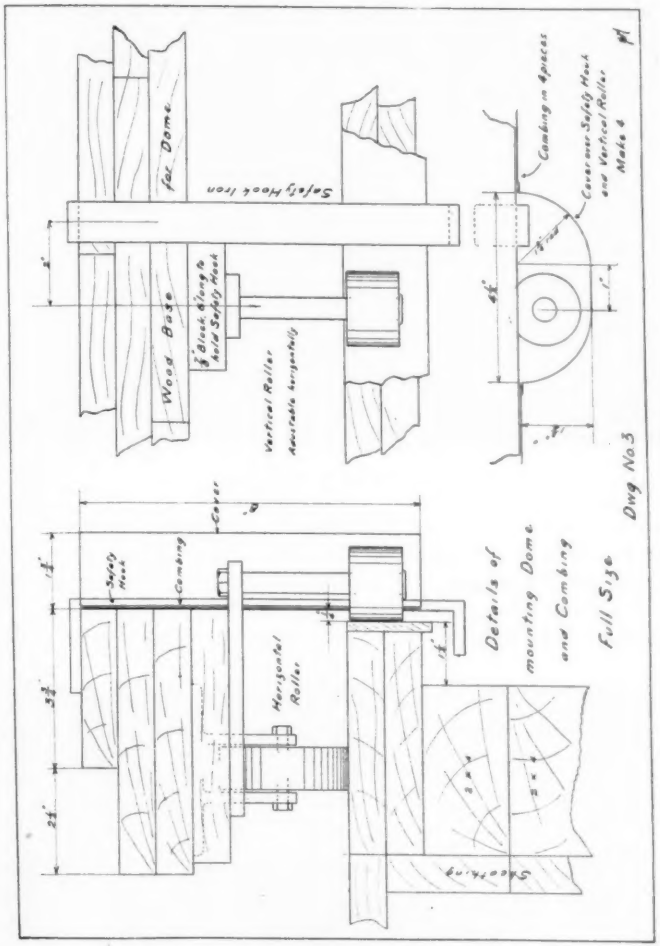
For the busy man who wishes to do some useful work with a telescope, and at the best can give only a few hours a month to the work, an observatory of some kind is almost as important an item of equipment as the telescope. This idea is well expressed by Webb in his *Celestial Objects for Common Telescopes*, when he says, "An



observatory is by no means essential, but it would be difficult to overestimate its advantages in point of comfort as well as economy of time." While one may easily purchase a suitable telescope, the acquisition of an observatory is another question, for they cannot be found "ready made."

When I decided to build an observatory for my 4-inch Clark equatorial, I drew my own plans being unable to find any complete enough






to be of much assistance, and plans are necessary if you want to have a contractor give an estimate of the cost of construction. My first attempt was a building with a four hipped roof removable in sections as shown in one of the illustrations. This was built but was not entirely satisfactory owing to the time required to remove the roof sections, and to the resultant exposure of the greater part of the interior to the weather. This last point is of importance for with a dome one may observe with comfort in windy and cold weather.

The cost of the conventional dome seemed prohibitive owing to the

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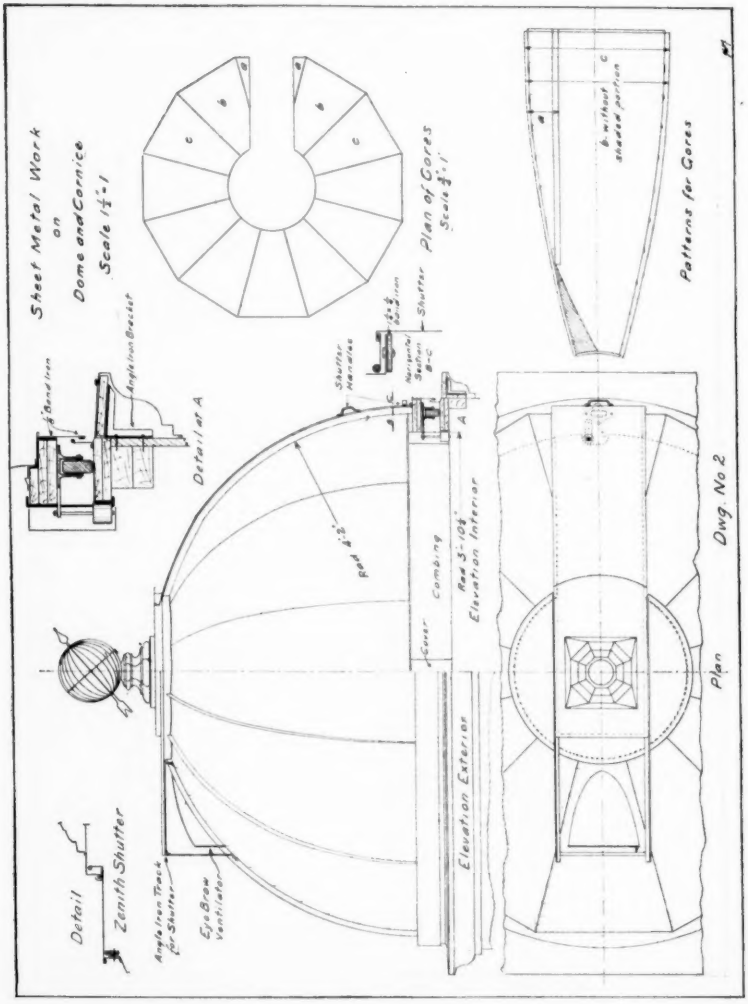

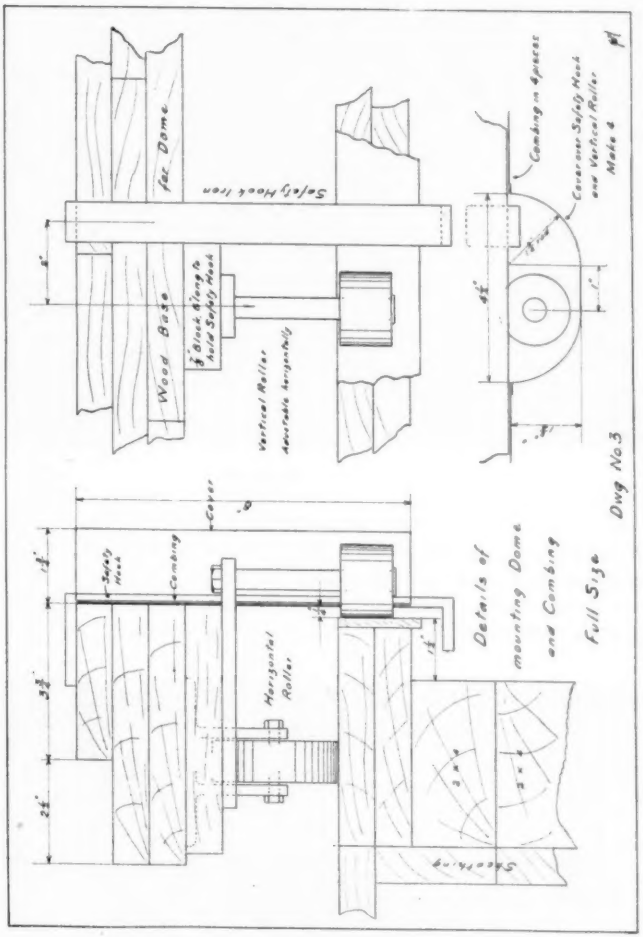


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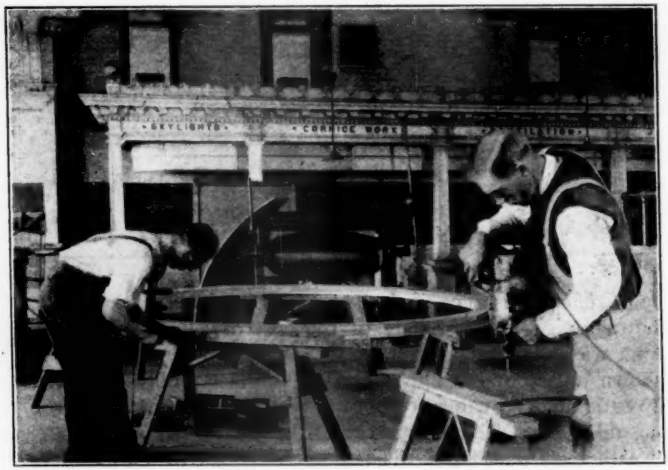
The cost of the conventional dome seemed prohibitive owing to the

MAKING BASE FOR DOME.

necessary steel frame work and track; and even if built entirely of wood the framing is likewise an expensive and difficult job. I wanted to design an inexpensive dome which would not require a track and interior framework; depending upon the design and material of the dome itself to give the necessary rigidity. The result was the observa-




PUTTING IRON BAND ON DOME BASE.

tory I am about to describe which has been built and used for the past year.

The dome was built by the pupils of the Sheet Metal Department of the Baron de Hirsch Trade School, New York, under the direction of Mr. William H. Gruening, the Instructor in Sheet Metal Work who likewise gave me the benefit of his expert knowledge in working out the details of the sheet metal work. For convenience in shipping to my residence in New Jersey the dome was built in three sections, and taken there in my automobile, then assembled and erected by Mr. Gruening, Mr. Paul Balze, Instructor in Plumbing, and myself. From these illustrations, working drawings and description, one may design a dome to suit his requirements, and any competent sheet metal worker should be able to construct a similar one.

The original features of this design may be briefly enumerated as follows:

1. The dome does not revolve on a track, and in consequence its revolving quality is not affected by any change in its shape owing to unequal expansion or contraction, a defect common with most small domes.

2. It has no interior framework such as ribs, as the feature of standing seams gives sufficient rigidity to the dome; and in addition we get the full benefit of its interior diameter.

3. It revolves with ease, and is practically noiseless in operation as the iron wheels roll on a flat wooden surface.

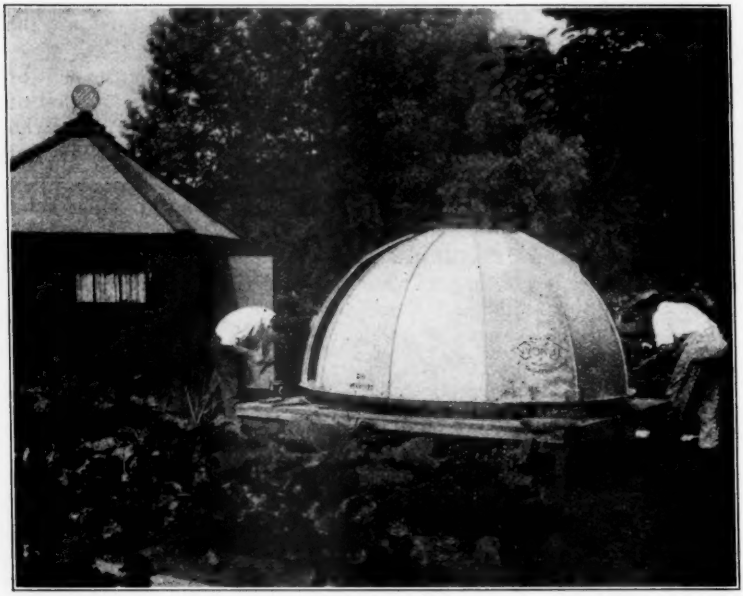
4. It is easier to construct than a true hemispherical dome, and more pleasing architecturally.

### CARPENTRY AND MASONWORK.

The foundation and floor are of concrete. Four half-inch bolts were set in the center of the floor to hold the pier for the telescope mounting.

The framework spruce sills fastened to the foundation by bolts set into the concrete. The covering is of 7/8-inch tongue and groove edge bead partition stuff set vertically. The details of the floor or plate upon which the dome revolves are clearly shown on Dwg. 1. This floor is bolted to the plate of the building. This floor should be carefully made, the joints flush so that the dome rollers will run smoothly. Also a pitch should be given to each corner as shown, so that rain will not settle on the flat corners of the roof.

The wood base ring upon which the dome is mounted consists of 36 pieces in all of 7/8-inch pine. It is made in three layers lapped one-third of their length, the upper layer giving the shape of the base of the dome which is a polygon of twelve sides. The pieces were painted before being fastened together. Flathead wood screws were used, No. 12 1¼-inch for lower layers, and No. 10 2¼-inch for fastening top layer to the others. An iron band ⅛ x 1¾-inch was drawn tightly around this ring by means of carpenter's clamps, and fastened to



ASSEMBLING THE DOME.

the ring with wood screws. As the ring was made in three pieces, short plates 8 inches long were drilled and tapped and fastened to the inside of the ring with machine screws. All of these features are clearly shown in Dwg. 1, and the illustrations.

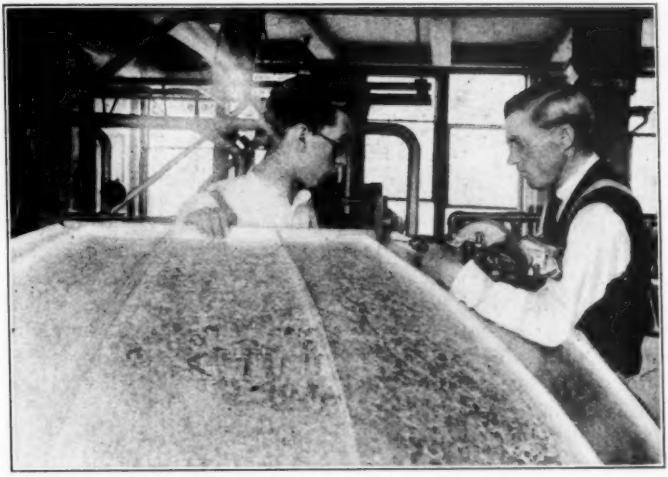
The interior of the building is finished with Beaver Board which comes 4 feet wide, the joints being covered with a cypress rectangular strip, giving a panel effect. The same idea answers for trim around the windows. This Beaver Board finish is cheap and a convenient surface to which to attach diagrams and charts. A plain surbase was placed at the bottom of the walls. The interior walls were painted a dark buff color, and the interior of the dome dead black.

Dwg. 3 will indicate the assembly of the horizontal and vertical rollers. The four horizontal rollers are ordinary rubber-tired truck rollers which can be obtained at any hardware establishment, the four vertical rollers are not a stock article and were made in a machine shop. These vertical rollers are adjustable horizontally, their purpose being to keep the dome centered. They should be set to just bear loosely on the hardwood bearing strip around the circular opening of the plate. The four safety hook irons are likewise shown and are intended to hold the dome in place should the wind at any time lift it.

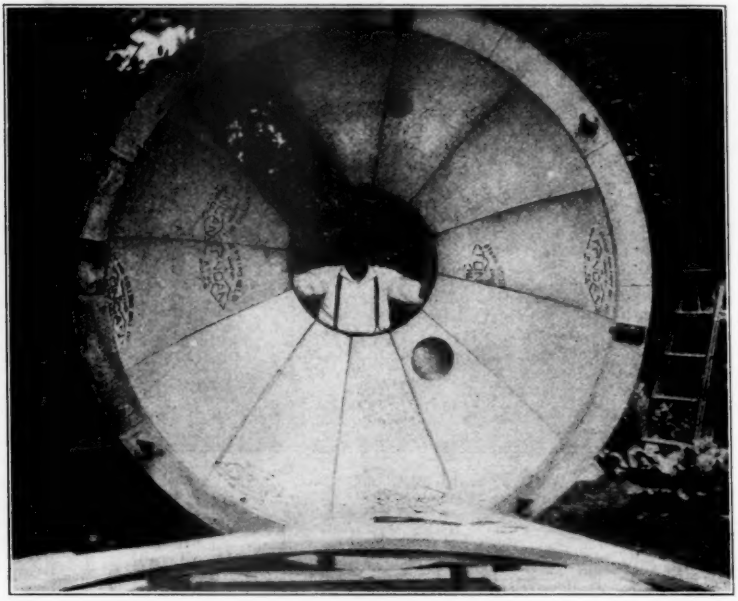
MAKING THE IRON EDGE BAND.

SHEET METAL WORK.

The development of the gore shaped patterns is shown in Dwg. 2. It might be well to state that in order to layout such large patterns as these, quarter size drawings should be made, and from these the full size patterns laid down on the metal by transferring all dimensions en-



FITTING IRON EDGE BAND.



THE DOME AND WOOD PLATE OR FLOOR.

larged four times. Great accuracy must be exercised in this work as a small error in the pattern will not only considerably change the shape of the dome, but make the assembling of the various parts a more difficult job.

No. 24 Toncan metal, a grade of galvanized iron, was used for the gores, and No. 20 for the top. The gores were joined together by a 1-inch standing seam. A single edge 1-inch wide was left on one side, and a double edge 1½ inches wide on the opposite side, of all patterns except the partial gores near the opening. After forming the metal on light rollers the edges were flanged out on a stake with flanging hammer and mallet. The rivet holes previously prick marked 6 inches on centers were now punched with a Whitney punch. The ½-inch edge of the wide flange was now turned over on the turning machine, and afterwards the gores were riveted together, dressed down with a mallet and then soldered. Care must be taken in turning the edges of the gores to allow for the take-up of the metal which varies as the curvature of the gore changes.

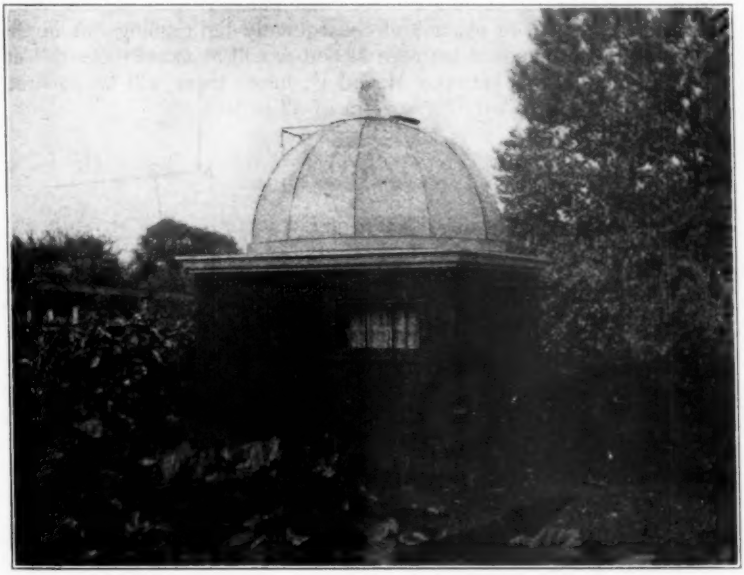
A band of No. 20 galvanized iron correctly punched 2 inches wide and of proper length, was used for checking the position of the gores on top, the gores being temporarily bolted to this band and afterwards riveted and soldered. A piece of band iron 1¼-inch x ¼-inch was

then made to fit exactly the band above described. This was circular in shape, but not a complete circle owing to the slit opening. Joined to this were strips the shape of the edge of this slit. This gave a continuous edge band of iron to the slit and the circular top of the dome which, being fastened to the dome itself with stove bolts, gave it sufficient stiffness to hold its shape. As the shape of the edge band at the sides of the slit is not a true circular arc, Dwg. 1 shows how its true shape may be obtained. The pattern for the top had a lap which was peined over the flange of the cap strip. The latter was fastened to the inner iron edge band frame with stove bolts.

The shutter covering the slit was made 1½ inches wider than the opening, which was 17 inches, the side strips being 1½ inches wide, double seamed and wired. This shutter is held in place by a latch at the bottom and a hardwood swivel cross bar at about the center of the shutter. It is removed from the outside of the building, and for that purpose handles are provided as shown on the drawing.

The detail for the zenith shutter is shown in Dwg. 2, also the angle iron framework which supports it when open. It is operated from the inside of the building by cords running through shade pulley wheels fastened to the inside of the dome.

The ventilator and the globe ornament are not essential but add much to comfort and appearance of the dome.



THE OBSERVATORY.

The outside of the dome was painted a French Grey. First a coat of white lead, then a coat of enamel. Six months later it was given a second coat of enamel and should not require repainting for several years to come.

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## AN ELEMENTARY VIEW OF DIFFRACTION AS APPLIED TO PHOTOGRAPHIC PHOTOMETRY.

By ALICE H. FARNSWORTH.

*(Continued from page 333.)*

*Effect of Removing the Grating.*[19] It is easily seen that the effect of removing the grating is to destroy the spectra, leaving only the central image. Suppose AC (Fig. 7) is opaque with adjacent slit CF; M is the middle point of AF. It has previously been shown that spectra of the first order appear in the direction FG if $FG = \lambda$, i. e. $MN = \lambda/2$. Now imagine CA removed so that the aperture AF is free. Since $MN = \lambda/2$, corresponding to any point K along AM is a point K′ between M and F which is just half a wave-length further from AG. Waves, therefore, which start in the same phase from K and K′ must reach AG in opposite phase and consequently light going out in the direction FG from points between M and A will be exactly neutralized by light from points between M and F; hence there will be no first-order spectrum; similarly for spectra of all orders.

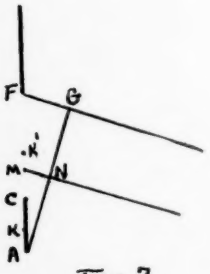


Fig. 7

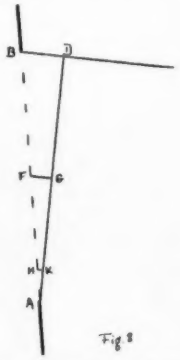


Fig 8

*n Slits.* When the number of slits is increased beyond two, spectra of the 3rd class[20] are obtained which, however, disappear entirely if the

[19] Kimball, p. 658.
[20] Wood, p. 168.

number of slits is very large. These spectra are so faint relative to those of the second class that they do not enter into the practical problem of wire gratings and will therefore be treated briefly.

For the remaining diagrams we will assume the plane wave ⊥ to the grating, the lens, and the screen, and show simply the path relations at the grating, since these determine the positions of maxima and minima. For simplicity assume an even number *(n)* of slits each with adjacent opaque region in the aperture AB. (Fig. 8).

In a direction ⊥ to the grating, since all points along AB are in the same phase of vibration, their effects will unite to produce a central bright maximum with an amplitude of vibration equal to $n$ times that produced by one slit.

Consider the situation in a direction perpendicular to AD.[21]

(a) If

$$BD = \lambda, 3\lambda, 5\lambda, \text{---} \quad FG = \lambda/2, 3\lambda/2, 5\lambda/2, \text{--} \quad (2m+1)\lambda/2$$

and the series of particles along DG is out of phase with that along GA and minima due to interference between halves of the grating result; where

$$\sin\theta = \frac{FG}{n(a+d)/2} = \frac{(2m+1)\lambda/2}{n(a+d)/2} = \frac{(2m+1)\lambda}{n(a+d)} \qquad (13)$$

(b) If

$$BD = 2\lambda, 4\lambda, 6\lambda, \text{----} \quad FG = \lambda, 2\lambda, 3\lambda, \text{----} \quad 2m\lambda/2$$

and corresponding points along DG and GA are in the same phase and maxima due to superposition of vibrations of the same phase result; where

$$\sin\theta = \frac{FG}{n(a+d)/2} = \frac{2m\lambda/2}{n(a+d)/2} = \frac{2m\lambda}{n(a+d)} \qquad (14)$$

(c) If

$$BD = 3\lambda/2, \quad FG = 3\lambda/4$$

and the first third of the grating will interfere destructively with the second third, leaving the last third to produce slight illumination or a secondary maximum. Similarly if $BD = 5\lambda/2$, a slight maximum due to 1/5 the grating occurs.

(d) To the minima discussed under (a) must be added those resulting from destructive interference between two slits, i. e. 2nd class minima, which may annul the effect of maxima discussed under (b) in accordance with a principle analogous to that stated under 2) on page 332.

(e) If in equation (14) $m$ becomes $n$, then

$$HK = \lambda, \quad BD = n\lambda, \quad FG = n\lambda/2, \quad \sin\theta = \frac{n\lambda/2}{n(a+d)/2} = \frac{\lambda}{a+d}$$

[21] Crew, p. 489; Müller-Pouillet, pp. 804, 5.

or more generally, if

$$\mathrm{HK} = m\lambda,\ \mathrm{BD} = mn\lambda,\ \sin\theta = m\lambda/(a+d) \qquad (15)$$

This equation is identical with (12) and the maxima produced for these values of $\theta$ are the first intense maxima on either side the central image. They are the spectra of the diffraction grating (Fraunhofer's 2nd class).

Table 1 makes clear the effect of the maxima and minima produced by 1 and 2 slits on the maxima and minima discussed under (a) and (b). The values of sin $\theta$ for groups of 1, 2, 4, and 8 slits are tabulated.[22] For brevity, $b$, known as the "grating space", is substituted for $(a+d)$. The data for groups A and B come from substitution of small integers for $m$ in the general formulae (8), (9), (11), and (12). Note that certain of the maxima in group B disappear when $b/a$ is an integer. In groups C and D, the first line (unaltered) gives the maxima and minima obtained from equations (13) and (14). Comparison of values in column 4 of groups B and C with those in column 3 of groups C and D, respectively, shows that certain of the maxima must be ruled out because of destructive interference between smaller groups of slits. In other words, if we think of slits being added successively, no maximum can exist where a minimum has been previously established. Such maxima have been enclosed in parentheses and added in italics to the column of minima. The second line in groups C and D thus gives the effective maxima and minima.

Fig. 11 (cf. Müller-Pouillet, Table VI; also Wood p. 171) shows curves plotted from the data of Table I. The abscissae are the values of sin $\theta$, and the ordinates represent approximate intensities. Curve A is made on the assumption that $a = b/2$; curves B, C, and D, on the assumption that the ratio between the free space and the opaque region (which together make up $b$) is not an integer. [Note that the "$a$" of curve A is thus not the same as the "$a$" in the expression $b = (a+d)$. This should not lead to confusion as this latter "$a$" is not used in the table.] The scale of the ordinates for curve A is not the same as that used for the other three.

Study of the table and the curves shows:

1. Principal maxima remain only where $b \sin\theta$ is an integral multiple of $\lambda$.
2. Between each two principal maxima lie $(n-1)$ minima. As $n$ increases the number of minima increases until the space between the principal maxima is practically dark.
3. The $(n-2)$ secondary maxima which separate the $(n-1)$ minima are not tabulated in Table I. Their presence may be inferred from the suggestion under (c) on page ? They may be

[22] Müller-Pouillet, pp. 803-6.

TABLE I.

| Group | No. of Slits | Maxima | Minima |
|---|---|---|---|
| | | Sin $\theta$ = | sin $\theta$ = |
| A | 1 | $\left(0, \frac{1}{2}, \frac{3}{2}, \frac{5}{2}, \frac{7}{2}, \cdots\right)\frac{\lambda}{a}$ | $\left(\frac{2}{2}, \frac{4}{2}, \frac{6}{2}, \frac{8}{2}, \cdots \frac{2m}{2}\right)\frac{\lambda}{a}$ |
| B | 2 | $(0, 1, 2, 3, \cdots \mu)\ \frac{\lambda}{b}$ | $\left(\frac{1}{2} \cdot \frac{3}{2} \cdot \frac{5}{2} \cdot \frac{7}{2}, \cdots\right)\frac{\lambda}{b}$ |
| | | 2nd class maxima fall at places of 1st class minima if $\frac{2m\lambda}{2a} = \frac{\mu\lambda}{b}$ or $\frac{\mu}{m} = \frac{b}{a}$ = an integer | |
| C | 4 | $\left(0, \frac{(2)}{(4)}, \frac{4}{4}, \frac{(6)}{(4)}, \frac{8}{4}, \cdots\right)\frac{\lambda}{b}$ | $\left(\frac{1}{4}, \frac{3}{4}, \frac{5}{4}, \frac{7}{4}, \frac{9}{4}, \frac{11}{4} \cdots\right)\frac{\lambda}{b}$ |
| | | $\left(0, 1, 2 \cdots\right)\frac{\lambda}{b}$ | $\left(\frac{1}{4}, \frac{2}{4}\ \frac{3}{4}, \frac{5}{4}, \frac{6}{4}\ \frac{7}{4}, \frac{9}{4}\ \frac{10}{4}\ \frac{11}{4}, \cdots\right)\frac{\lambda}{b}$ |
| D | 8 | $\left(0, \frac{(2)}{(8)}, \frac{(4)}{(8)}, \frac{(6)}{(8)}, \frac{8}{8}, \frac{(10)}{(8)}, \frac{(12)}{(8)}, \frac{(14)}{(8)}, \cdots\right)\frac{\lambda}{b}$ | $\left(\frac{1}{8}, \frac{3}{8}, \frac{5}{8}, \frac{7}{8}, \frac{9}{8}, \frac{11}{8}, \frac{13}{8}, \frac{15}{8}, \frac{17}{8}, \cdots\right)\frac{\lambda}{b}$ |
| | | $\left(0, 1, 2 \cdots\right)\frac{\lambda}{b}$ | $\left(\frac{1}{8}, \frac{2}{8}\ \frac{3}{8}, \frac{4}{8}\ \frac{5}{8}, \frac{6}{8}\ \frac{7}{8}, \frac{9}{8}\ \frac{10}{8}\ \frac{11}{8}\ \frac{12}{8}\ \frac{13}{8}\ \frac{14}{8}\ \frac{15}{8}, \frac{17}{8}, \cdots\right)\frac{\lambda}{b}$ |

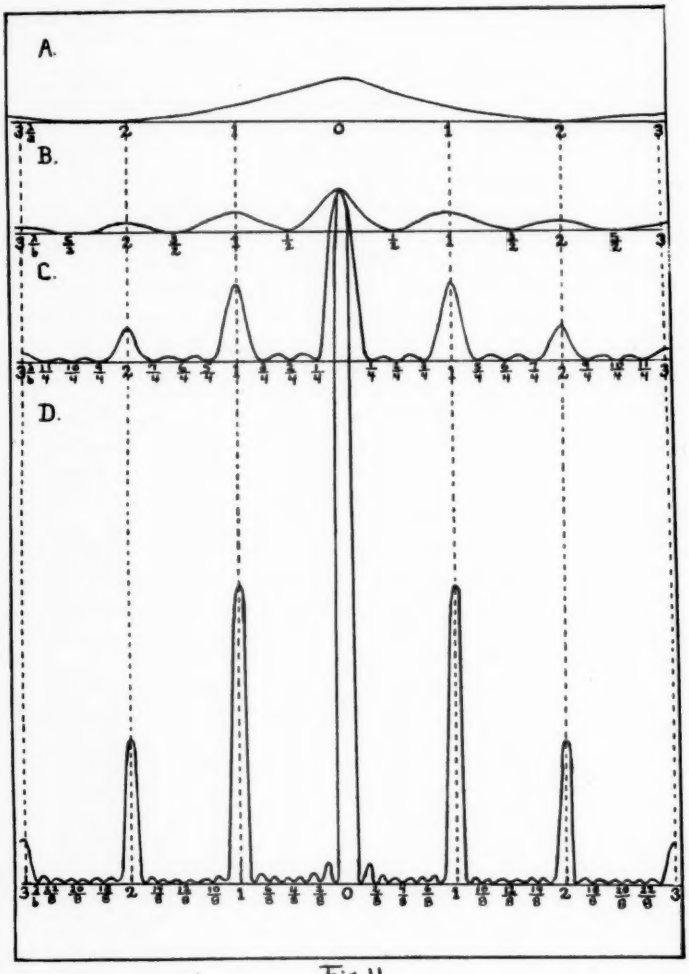


Fig. 11

regarded in effect as interference fringes about the principal maxima[23] and are symmetrical with respect to them. (For an interesting non-mathematical discussion of these 3rd class maxima see Wood in *Phil. Mag.* (6th series) **14**, 477, 1907.)

4. The principal maxima grow narrower with increasing $n$ because the minima draw closer and closer to them.

[23] Baly, p. 161.

5. The principal maxima increase in intensity, as more slits are added, in proportion to the square of the number of openings.
   If amplitude of vibration from 1 slit is $a$, $I_1 \propto a^2$
   " " " " 2 " $2a$, $I_2 \propto 4a^2$
   " " " " 3 " $3a$, $I_3 \propto 9a^2$
   Thus $I_2 = 4I_1$, $I_3 = 9I_1$, etc.
6. Paragraphs 1) to 5), page 332, apply for all values of $n$.
7. With reference to the intensities shown by the ordinates, the discussion up to this point accounts for the form of curve A (see page 335), and the relative heights of B, C, and D; but the relative heights of the maxima belonging to any one curve depend on the ratio $a/d$, and will be treated in the next section.

It is very evident that for practical purposes only the spectra of the second class, represented by the principal maxima of curves B, C, and D, need be considered. The intensity of the central maximum and that of the spectral images will now be compared with that of the free image obtained without the grating.[23]

Let $I_f$, $I_c$, and $I_s$ represent the intensities of the free, central, and spectral images respectively. Referring to Fig. 8, find first the relation between $I_c$ and $I_f$. If $A_c$ represents the amplitude of the resultant of vibrations coming from one slit, then $(nA_c)$ gives the resultant amplitude from AB. Therefore, since intensity is proportional to the square of the amplitude,

$$I_c \propto n^2 A_c^2$$

If now the bars are removed, each A will be increased by an amount depending on the ratio of the width of the slit $(a)$ to the grating space $(a+d)$. That is,

$$A_f = A_c\,(a+d)/a. \quad \text{Hence } I_f \propto [n A_c (a+d)/a]^2 \text{ and}$$
$$I_c/I_f = [a/(a+d)]^2 \qquad (16)$$

The formula for the relation between $I_c$ and $I_s$ is not easily derived by elementary methods. The attempt that is made here follows Baly rather closely and is based on Lord Rayleigh's treatment.[24]

Consider first the effect of the aperture AB (Fig. 9); it receives plane waves perpendicular to itself. BC is the direction of the central maximum. BP is such a direction that BD does not equal $m\lambda$ and we wish to find the resultant of secondary waves in this direction. E is a particle in the aperture transmitting the wave EF; G is a similar particle transmitting the wave GH, which is retarded upon EF by the path-difference GK. If, in Fig. 10, the circumference of the circle represents T, the period of vibration, and $ab$ is the amplitude of vibration

[23] Baly, p. 161.
[24] Baly, p. 158; Enc. Brit. B, 246; Wood, p. 182.

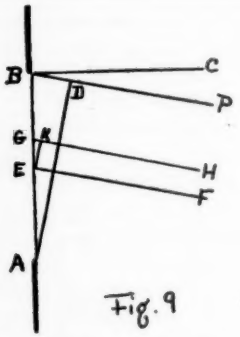

Fig. 9

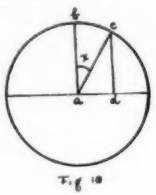
Fig 10

of the wave due to the element E, then the arc *bc* is the short space of time the wave from G is behind that from E, *cd* is the amplitude of wave from element G, and the angle $x$ represents the angular retardation of the wave from G (with respect to E).

Thus

$$x/2\pi = \mathrm{GK}/\lambda \text{ or } x = 2\pi\,\mathrm{GK}/\lambda \qquad (17)$$

Cf. page 328.

Now

$$cd = ab\cos x\,,$$

or, if *ab* be taken as unit,

$$cd = \cos x\,;$$

or, expressed in words, the amplitude of the vibration from G equals the cosine of the angular retardation. Hence the amplitude of the resultant from AB at the focus of the lens is the sum of all the amplitudes $\cos x\,.\,dy/\mathrm{AB}$, where $dy/\mathrm{AB}$ is the ratio of the size of the element at G to the whole aperture AB.

In order to obtain an expression equivalent to $dy/\mathrm{AB}$ in terms of $x$, call R the angular retardation between the extreme waves from the elements at A and B.

Then

$$\mathrm{R}/2\pi = \mathrm{BD}/\lambda, \text{ or } \mathrm{R} = 2\pi\mathrm{BD}/\lambda \qquad (18)$$

and

$$\mathrm{R}/\mathrm{AB} = x/\mathrm{y}\,,$$

where $x$ is the angular retardation between two elements separated by a distance $y$, whence

$$dx/\mathrm{R} = dy/\mathrm{AB}$$

Substituting $dx/\mathrm{R}$ for its equal in the above expression for the amplitude of the resultant:

$$\text{Amp. of resultant} = \Sigma\cos x\,dx/\mathrm{R} \qquad (19)$$

From symmetry, the phase of the resultant will necessarily always correspond with that of the secondary wave which issues from the

center of the aperture. Suppose now that E is the center of the aperture, then the angular retardation between E and either A or B is R/2. Summing all the disturbances cos $x\ dx$/R as $x$ varies from —R/2 on one side of E to + R/2 on the other, and assuming the amplitude in the principal direction BC to be 1 :

$$\text{Amplitude of resultant} = \int_{-R/2}^{+R/2} \frac{\cos x\, dx}{R} = \frac{\sin R/2}{R/2} \qquad (20)$$

Equation (20) with equation (18) enables us to determine the intensity of these interference fringes from one aperture, given the path-difference between the extreme vibrations.

| BD | R | Amplitude | Intensity | |
|---|---|---|---|---|
| 0 | 0 | 1 | 1 | Central image |
| $\lambda/2$ | $\pi$ | $2/\pi$ | $4/\pi^2$ | Cf. page 332 |
| $\lambda$ | $2\pi$ | 0 | 0 | 1st minimum |
| $3\lambda/2$ | $3\pi$ | $2/3\pi$ | $4/9\pi^2$ | 1st maximum, etc. |

Now consider the effect of introducing over the aperture a grating with dimensions $a$ and $d$ We have already seen that we now obtain

1) A central image such that $I_e/I_t = [a/(a+d)]^2$
2) Principal maxima on each side the central image when BD = $mn\lambda$, where
   $n$ = number of slits
   $m$ = order of spectrum
3) On either side the principal maxima, distribution of illumination according to the same law as for the central image, minima occurring when the retardation (BD) amounts to $(mn \pm 1)\lambda$.

It is the intensity of the principal maxima under 2) which is now to be determined. The effect of each aperture of the grating on the brightness of the spectral image is the same. When the aperture was without the grating

$$R = 2\pi BD/\lambda,$$

where BD is the projection of the aperture upon the direction under consideration. With the grating in place the integration must be limited to the transparent parts of the aperture and only $a/(a+d)$ of the elements be summed. Thus R becomes equal to

$$2\pi BD/\lambda \,.\, a/(a+d) = 2\pi ma/(a+d)$$

where $m$, the order of the spectrum $= BD/\lambda$.

Substituting this value of R in the previous integral (20) and squaring it to obtain the intensity (noting that $I_e$ has been assumed unity),

$$I_s = \left[ \int_{-am\pi/(a+d)}^{+am\pi/(a+d)} \frac{\cos x\, dx}{2am\pi/(a+d)} \right]^2 \qquad (21)$$

$$= \left( \frac{a+d}{2am\pi} \right)^2 \left[ \sin^2 x \right]_{-am\pi/(a+d)}^{+am\pi/(a+d)} = \frac{(a+d)^2}{4(am\pi)^2} \left( 2 \sin \frac{am\pi}{a+d} \right)^2$$

$$= \left( \frac{a+d}{am\pi} \right)^2 \sin^2 \frac{am\pi}{a+d} \qquad \text{in terms of } I_c$$

Thus we may write

$$\frac{I_s}{I_c} = \left( \frac{a+d}{am\pi} \right)^2 \sin^2 \frac{am\pi}{a+d} \qquad (22)$$

Combining (22) with (16)

$$\frac{I_s}{I_t} = \frac{1}{m^2\pi^2} \sin^2 \frac{am\pi}{a+d} \qquad (23)$$

It is evident that $I_s$ vanishes when $\sin am\pi/(a+d) = 0$; i. e. when

$$am\pi/(a+d) = \pi, 2\pi, 3\pi \text{- - - - -}$$

This occurs when

$$m = (a+d)/a\,,\ 2(a+d)/a\,,\ 3(a+d)/a \text{- - - -}$$

Thus for

$d = a$, $m = 2, 4, 6, \text{- - -}$ i. e. 2nd, 4th, 6th - - - orders vanish
$d = 2a$, $m = 3, 5, 7, \text{- - -}$ 3rd, 5th, 7th - - - " " etc.

If $a$ is small compared to $(a+d)$, then, except for higher orders, equation (23) simplifies, by putting the small angle $am\pi/(a+d)$ for its sine, to $I_s/I_t + [a/(a+d)]^2$ and the brightness of all the spectra is the same.

*Design of Grating*[25]. Referring to page 461 we see that the expressions for the position of spectra all reduce to $\sin\theta = m\lambda/(a+d)$. Let

$f$ = the distance from grating to focal plane of the telescope
$D$ = distance between centers of central and spectral images.

Then

$$\sin\theta = D/f,$$

whence for 1st order spectrum

$$D = f\lambda/(a+d). \qquad (24)$$

If the source is white light,

For blue rays $D_b = f\lambda_b/(a+d)$ ; for red rays $D_r = f\lambda_r/(a+d)$
Hence length of spectrum $= D_r - D_b = f(\lambda_r - \lambda_b)/(a+d)$. (25)

From equations (24) and (25) it appears that

[25] Chapman and Melotte, p. 50.

1) D is inversely proportional to $(a + d)$ and not dependent on the relation between $a$ and $d$.

2) The length of the spectrum is inversely proportional to $(a + d)$. Hence in the design of a grating, to obtain round spectral images, $(a + d)$ must be great enough so that the length of the spectrum (due to $\lambda_r - \lambda_b$ for which the plate is sensitive) may be short enough to be masked by the photographic irradiation through its tendency to make a round image; at the same time $(a + d)$ must not be so great that $D$ thereby becomes small enough to cause overlapping of central and spectral images throughout the desired range of magnitude.

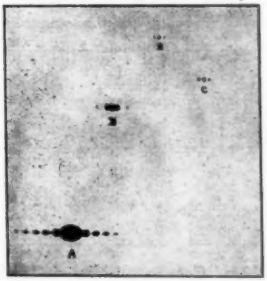

Fig. 13. Spectra obtained with "Normal" Grating.

Fig. 13 shows the spectra of Alcyone and three neighboring stars of the Pleiades obtained with a "normal" grating (see p. 468) on the 40-inch telescope of the Yerkes Observatory.

*Grating Constants.* The *absorption* of the grating, or difference in magnitude between free and central images is deduced from Fechner's law[28] and equation (16), given the ratio of $a$ to $d$.

$$I_c/I_t = a^2/(a+d)^2 = \rho^{\Delta M_{c-t}}$$

where $\rho =$ the light-ratio $= 2.5$ and $\Delta M_{c-t} =$ the absorption.

$$\Delta M_{c-t} \log 2.5 = 2 \log [a/(a+d)]$$
$$\Delta M_{c-t} = 5 \log [a/(a+d)] \qquad (26)$$

Similarly the *magnitude interval,* or difference in magnitude between the central and spectral images is derived from the same law and equation (22), given $m$, the order of the spectrum and the ratio $a/d$.

$$\frac{I_s}{I_c} = \left(\frac{a+d}{am\pi}\right)^2 \sin^2 \frac{am\pi}{a+d} = \rho^{\Delta M_{s-c}}$$

$$\Delta M_{s-c} \log 2.5 = 2 \log \left(\frac{a+d}{am\pi} \sin \frac{am\pi}{a+d}\right)$$

$$\Delta M_{s-c} = 5 \left(\log \sin \frac{am\pi}{a+d} - \log \frac{am\pi}{a+d}\right) \qquad (27)$$

[28] Furness, p. 98.

By means of equations (26) and (27) the absorption and magnitude interval for any value of $a/(a+d)$ may be computed. Fig. 12

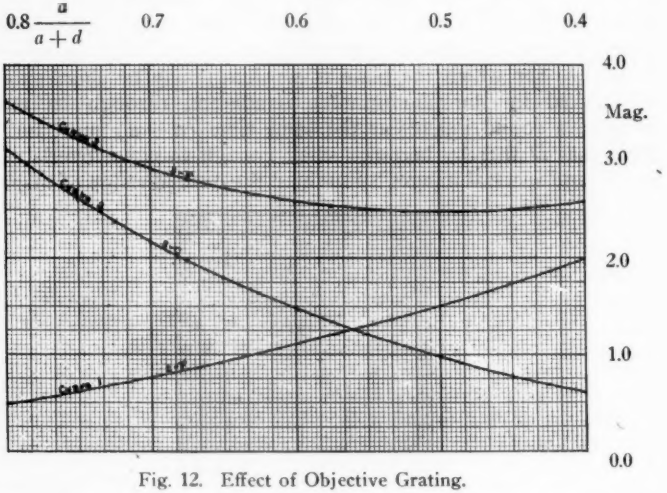


Fig. 12. Effect of Objective Grating.

shows curves based on such data for values of $a/(a+d)$ (abscissae) between 0.8 and 0.4. The ordinates for the three curves represent the difference in magnitude between free and central, central and spectral, and free and spectral, respectively, the third being obtained by addition of the first two. Curve 3 shows the difference in magnitude between free and spectral images to be a minimum for the "normal" grating, i. e. one in which the transparent space equals the opaque space. Several advantages accrue from the use of the normal grating:

1) The spectra of even orders disappear [see equation (23)] so that danger of overlapping of first order spectra with the next is eliminated. (See Fig. 13, B, C, D.)

2) At the same time the spectra of odd orders reach a maximum. Third order spectra of bright stars are thus often visible with ordinary exposure times. (See Fig. 13, B.)

3) Curve 3 changes slope very slowly in the neighborhood of

$$a/(a+d) = 0.5,$$

so that measures of the dimensions of the grating of moderate accuracy yield a precise value for the difference in magnitude between free and spectral images.[27]

[27] Hertzsprung, p. 178.

SUMMARY.

The phenomena of diffraction are discussed from an elementary point of view in sufficient detail for an understanding of the use of the parallel wire grating for the determination of scale in photographic photometry. Full references are given to the standard texts from which most of the material has been taken.

1. The introduction involves Huyghens' principle of the rectilinear propagation of light and the general notion of wave-motion with definition of terms. The equation showing the displacement of particles in simple harmonic motion to be a sine function; the expression for the resultant of two wave-motions of the same amplitude; and the relation: intensity is proportional to the square of the amplitude, are derived.

2. After treatment of Fraunhofer's 1st, 2nd, and 3rd class spectra (formed by one, two, and $n$ slits respectively), the results of the interaction of all three are tabulated and plotted. Especial emphasis is given to the spectra of the second class which are those of the diffraction grating.

3. The ratio of intensity between free image and central maximum follows from the relation between intensity and amplitude. The intensities of the spectra, in terms of that of the central maximum, depend on the integration of all the amplitudes of vibration from the transparent parts of the aperture. The relation between free and spectral images follows immediately from the two preceding ratios.

4. Application of the theory to the wire gratings used in photometry enters 1) in the design of the grating according to the formula $D = f\lambda/(a + d)$, involving the coarsness of the grating space, the color-sensitiveness of the plate, and the range of magnitude to be covered; 2) in the derivation of the constants of the grating from the relations obtained in 3., involving the ratio between the transparent and opaque parts of the aperture.

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## THE FIRST ATTEMPT TO ADOPT THE GREGORIAN CALENDAR IN ENGLAND.

By ROSCOE LAMONT.

When the reform of the calendar, published by Pope Gregory in 1582, was heard of in England it excited great interest and Queen Elizabeth decided to accept it. At that time there was living in England an astronomer and mathematician of some note named John Dee, famous also as an astrologer and spiritualist, and the papal plan was submitted to him for examination. Mr. Dee said:

"As Caesar and Sosigines
The Vulgar Kalendar did make,
So Caesar's pere, our true Empress,
To Dee this work she did betake."

Dee studied the matter carefully and made a report entitled, "A playne Discourse and humble Advise for our gratious Queen Elizabeth her most Excellent Majestie to peruse and consider, as concerning the needful Reformation of the Vulgar Kalendar for the civile yeres and daies accompting, or verifyeing, according to the tyme truely spent." His report was dedicated to Lord Burghley with the following verse:

Tò oti and Tò dioti[1]
I shew the thing and reason why,
At large, in brief, in middle wise
I humbly give a playne advise;
For want of tyme, the tyme untrew,
Yf I have myst, commaund anew
Your honor may, so shall you see
That love of truth doth govern me.

Dee approved of the reformation of the calendar and advised the acceptance of the plan of Pope Gregory, although he considered that it would have been better to have restored the equinox to the day of the month on which it fell at the birth of Christ, rather than at the time of the Nicene Council, thereby omitting, as he said, eleven days instead of ten. (In reality in that case twelve or thirteen days would have been omitted instead of eleven).

Dee's "playne discourse" was submitted to some men "very skilfull in the mathematicks", and the result of their examination was made known in a report by the Lord Treasurer Burghley to the Lords of the Council, a part of which is as follows:

"It was agreed by Mr. Digges, Mr. Savell, and Mr. Chambers, that upon their several perusal of the booke written by Mr. Dee, as a discourse upon the reformation of the vulgar callendar for the civill year, that they doe allow of his opinions, that where in the late Romaine Callendar reformed there are ten

[1]The why and the wherefore.

days cutt off to reduce the civill year to the state it was established by the councell of Nice, the better reformation had been, to have cutt off eleven days to have reduced the civill year according to the state the sun was in at the birth of Christ; and so they all accord with Mr. Dee, that such a reformation had been more agreeable to the accompt of Christians, but yet they doe also assent that having regard to the counsell of Nice the subtracting of ten days are agreeable to trueth, and therefore to accord the better with all the countries adjacent that have received that reformation of subtracting of ten days only, they think it may be assented unto without any manifest error, having regard to observe certen rules hereafter for omitting sum leape years in sum hundred years."

It was thought necessary, however, to refer the matter to the Archbishops and Bishops of the Church for their opinion, which was done in the following letter from Sir Francis Walsingham[1]:

Mr. Secretaries letter to the Archbishop of Canterbury tuching the alteration of the Calendar.

"It may please your grace. Uppon the setting furth latelie of a new Calendar in forren parts, called Calendarium Gregorianum, for the reformation of the ould received course of the year, wherebie there are now ten days cutt off in the new year, her majestie thinking it meet that the like reformation of the yere should be so receaved, and have his course in these her majesties realms and dominions, thereby to avoid diverse inconveniences that might otherwise follow, between her own and other princes her neighbors' subjects, by reason of the diversity of computations, hath caused this bearer, Mr. Dee, to set down a new calculation to be here published, to the said intended reformation of the yere, which my Lord Treasurer being directed by her majesty to refer to the consideration of Mr. Digges and two or three other very skilfull in the mathematicks, his Lordship hath returned answer that the said calculation is well lyked of as grounded upon good knowledge and probable reasons. Now, for that things of this nature ought in course to be referred to the considerations of the Archbishops and Bishops of the church, my lords of the councell doe therefore think meet that your grace, calling unto you such bishops as are about London, as the Bishops of London and Salisbury, and him of Lincoln, if he be not departed, should consider of the said new calendar, and thereupon return your opinion what you think of the same, and whether it be meet to be passed as it is set down, which it may please you to do with all convenient speed, for that it is meant the said callendar shall be published by proclamation before the first of May next; and so I humbly take my leave of your grace. Att Richmond, the 18th of March, 1582.

Your graces to command.
FRA. WALSINGHAM".

The year began in England at that time on March 25, and therefore the year 1583 began one week after the date of this letter.

The Archbishop did not reply "with all convenient speed" (so her Majesty thought), and eleven days later another letter was sent him by Sir Francis, a little sharper in tone, reading as follows:

"It may please your grace to understand that whereas I did of late send to you a reformation of the ould almanack set down by Mr. Dee and certain other learned in the mathematicks, which her majesty's pleasure was, should be considered of by yourself, and such other of the bishops as might be then about London before it were published, her majesty doth now find some fault that she doth yet hear nothing of the reports thereof that she looked to have received from your grace. Whereas you shall do well if that there be nothing don yet in the matter to call the said bishops presence unto you, and to consider of the said callendar with the assistance of Mr. Dee and such others as have been imployed in the setting down of the same; to the end you may thereupon deliver

[1]Gentleman's Magazine (London) November, 1851.

your opinion thereof according to her majesty's expectance, wherein you are to use the more speed so that the said kallendar is meant to be published by the first of May next. And so I committ your grace to God. At Richmond, the xxix of March, 1583.

Your graces to commande.
FRA. WALSINGHAM."

Although the reform of the calendar had been discussed for more than three hundred years, and the papal commission had studied the subject for six years, the Archbishop was expected to digest the matter in less than two weeks, which he considered a short time. But complying with the request for "more speed", on April 5, 1583, the Archbishop of Canterbury, and the Bishops of London, Rochester and Salisbury, addressed a letter to Secretary Walsingham, enclosing "certen reasons for this short time by us collected", in which they gave her Majesty to understand that they could not accept the proposed calendar, and they also transmitted "the judgment of some godly learned in the mathematicalls". Three papers forwarded, two in English and one in Latin, contained the "certen reasons" mentioned, which consisted of many objections to the plan proposed, three of which are quoted:

"10. Item, we think that it will be scandalous and offensive to all the world to yeald herein to the Pope, for it will be thought that we of the Clergie will be as ready to yeald unto them in other things.

"11. Item, because the Pope in his preface doth use these words, 'praecipimus' (we direct), 'mandamus' (we command), 'under payne of excommunication', if we should admitt it, we should seem to fear his excommunication who hath most presumptuously excommunicated the Queen, and so confirm the Papists and offend the weak brethren.[1]

"13. Item, the matter being of no great importance or necessity (as we thinke), especially because that the latter day approaching, as by all conjectures in the opinion of many godly learned wryters and divines, it is to be presumed there cannot happen or grow anye much greater alteration in the order and course of the year than is already, we do think that the Pope might very well have spared his labour in this matter, as the Church hath done from Christ's time hitherto."

The paper containing "the judgment of some godly learned in the mathematicalls" states that in the 300 years from the time of Christ to the Nicene Council the error of the calendar had amounted to one day, and that the Pope "had no respect to the trueth at all" or he would have omitted this one day also. But if the error of the Julian calendar had been only one day in 300 years, from the time of the Council of Nice in the year 325 to the reform of the calendar, in 1582, the error would have been only four days instead of ten. Mr. Dee was to blame for this mistake originally, but Mr. Digges, Mr. Savell and Mr. Chambers, "very skilfull in the mathematicks", and those "godly learned in the mathematicalls", might have worked out for themselves a problem of this difficulty. The error of the lunar cycle was one day

[1]The words in the papal decree translated "under payne of excommunication" do not refer to the acceptance of the calendar, but to the printing of the calendar and martyrology without the Pope's permission, the sole right to print the calendar having been given to Antonius Lilius.

in about 300 years, and they may have confused that with the error of the Julian year which was one day in 128 years.

As stated by Secretary Walsingham, the intention of the Government was to adopt the new calendar by proclamation of the Queen, to be published before May 1, 1583, Mr. Dee's plan calling for the omission of ten days from the months of May, June, July and August "without changing of any feast or holiday moveable or fixed." But this method of bringing the calendar into use was abandoned, for the divines informed Secretary Walsingham that the cutting off of days from certain months in this way could not be done legally, as the Book of Common Prayer containing the calendar was established by Act of Parliament, and such an alteration would be against the statute. No answer was found to this objection, and the whole matter either had to be dropped or the approval of Parliament obtained, and the latter course was decided upon. Parliament did not convene until November, 1584, and on March 16, 1584-85, the following bill was read the first time in the House of Lords: "An Act giving Her Majesty Authority to alter and new make a Calendar, according to the Calendar used in other Countries." On March 18 the bill was read a second time, and there is no further record of it. The Journal of the House of Lords shows that when the bill was read the second time there were present two Archbishops and twenty-two Bishops, and the wonder is that the Pope's calendar-bill got as far as a second reading. Until Sir Harris Nicolas published his "Chronology of History" in 1833, it was not known that any such bill had ever been introduced into Parliament.

Pope Gregory XIII, who died on April 10, 1585, was succeeded by Sixtus V, who began to aid Philip Second of Spain in his preparations designed for the conquest of England, and many besides the Archbishop may have thought that the latter day was approaching when the Pope's calendar would not be used, and that he "might very well have spared his labour in this matter."

Mr. Dee, who lived until the year 1608, in communing with the spirits revealed to them his grief because the calendar was not reformed "in the best terms of veritie."

The world did not come to an end as soon as the Bishops thought it would, and after various attempts to adopt the Gregorian calendar, it finally came into use in England in 1752. A full account of this matter is given in POPULAR ASTRONOMY for January, 1920.

Washington, D. C.

## SOME RECOLLECTIONS OF JOHN A. BRASHEAR.

By H. B. RUMRILL.

About fourteen years ago I became acquainted with "Uncle John" Brashear, after a very good mutual friend had presented me with a splendid four-inch object glass made in the famous shop on "the hill" in Allegheny—now known as Pittsburgh North Side.

Desiring to make a telescope mounting after original designs—but adhering to many of the standards established there—Mr. Brashear furnished, through correspondence, such parts as head ring and tail piece, and a visit was made to the shop in order to get some other parts for the mounting. (This telescope was described in POPULAR ASTRONOMY for June and July, 1911, and although since then a number of improvements have been added the essential principles of its construction remain unchanged and the instrument has more than fulfilled my expectations. On one occasion the dusky ring of Saturn was beautifully shown with a medium power eye-piece, and in general its performance is practically perfect).

But to return to that first visit to the shop. I asked humbly if I might see Dr. Brashear, who greeted me in that delightfully kindly manner that was indicative of his fine character, reassuring me by adding "Now sit down and tell me who you are, what you are, and what you mean to do in astronomy." My answers to those questions were followed by telling him how much I was indebted to reading Dick's *"Practical Astronomer,"* when he said "Ah, how much the world of science owes to Dr. Dick!" After a few minutes more of conversation, feeling that I must be encroaching on his time, I tried to end the interview by saying, "Now, Professor, I must pay your people for materials bought on my last order and not bother you any more just now." He replied "We can't talk money today; let's look through the shop." "Well, then," I said, "I'll send a check for the amount." He flashed back, "Darn your checks; we're going to look around the shop."

Two hours spent in examining the marvels of that wonderland of optical science were followed by a visit to the Observatory, where our good friend not only showed me the instruments and clocks, but operated the lantern in the lecture room, accompanied by a rarely interesting talk about the various slides. Then we went into the library, where he pointed out a number of the most important works on astronomy, many of which were collected by Langley, calling attention to a few books of doubtful value wherein the latter had registered his opinion by writing on the fly leaves the word "paradox."

Then came dinner at the house on Perrysville Avenue, adjoining the shop; but we were tardy and his good wife protested, "John, you are half an hour late, and I cooked the chicken myself just the way you like it, and now it is spoiled!" He replied, naively, "But, mother, you should excuse me, for we have a distinguished visitor today." (At which of course I demurred, assuring Mrs. Brashear that the chicken was absolutely perfect.) But she would not relent so easily, remarking "John, I'm ashamed of you!" when he arose demurely from the table, went to a little alcove in the wall and with a wry face said "This is my pouting corner; now, mother, isn't it all right?" A general laugh followed, with everyone in the best of humor, after which the chicken rapidly disappeared, and after dinner we had music (for Brashear was a great lover of music and an excellent critic.) At his genial command I played the piano, one of the pieces being Schumann's "Traumerei," a favorite of his, which he persuaded me to repeat several times.

That was a red letter day for the writer, but not the only one, for we became fast friends, and in succeeding years many pleasant hours were spent in his company.

On one occasion he severely criticized a remark of an astronomer of the old school, that there was little more to be learned in astronomy and that the heavens were a "worked-out mine." He also scored those who argue that the day of the small telescope has passed, and earnestly advised me to keep on the course I was pursuing, which included the collecting of books on astronomy and kindred subjects, and experimenting with apparatus. Upon showing him a sketch of an astronomical camera I had made, he asked why I had not brought it with me. "But," said I, "it isn't quite finished, although in working order." At this he remonstrated, "Don't you think I can understand an unfinished job?"

After associating with Brashear one felt a renewed sense of confidence and enthusiasm, for his own enthusiasm was contagious, a result of clean living and high thinking, and a heart to heart talk with him seemed to confer on one the freedom of the skies, with an undisputed right to prowl around among the stars.

Just as Hawthorne has told of the purity of the lily growing out of the stagnant mud of the river, so did Brashear emerge from the commercial environment of Pittsburgh, with its heavy black smoky incense to the great god Industry, and lead the way to great achievement, himself an exemplar of some of the noblest things for which life is worth living.

Berwyn, Pennsylvania,
September 5, 1920.

## FIRST STUDY OF HEAVENLY BODIES.

By MARY E. BYRD.

### LESSON VII.

Astronomers deal with such long periods of time that an interval of five or six months is short on their calendar, so it is not to be supposed that genuine star-gazers have, between May and October, lost interest in the lunar eclipse of the former month.

Hopes for clear skies were hardly realized. In sunny Kansas the eventful evening was cloudy; and, at Fall River, Wis., from which the best report came, haze and clouds interfered at first, for when the moon could be distinctly seen, "the eclipse was well under way." After that it was followed without interruption and its progress recorded on two circles, one representing the lunar disk as it was passing into the earth's shadow, and the other as it was emerging. Ten or more arcs drawn on these circles showed the varying position of the dividing line between the eclipsed and uneclipsed portions, and the accompanying table gave the hour and minute when each was drawn and the magnitude of the eclipse in twelfths of the lunar diameter.

Other features are described as follows:

"When observations begin, the shadow is indistinct, probably due to haze in the east, but it is very dark at the point of first contact during totality. The moon then appears in the sky as a copperish colored ball, shaded here and there by the lunar markings which are dimly visible to the unaided eye. Three planets are seen, Mars being the nearest, above and to the right of the moon, Saturn southwest of the zenith, and Jupiter still farther toward the southwest. Stars also are visible and I locate the moon on the straight line joining $\alpha$ Libræ and $\lambda$ Virginis, and midway between them."

"As recorded by my watch, which is fast about half a minute, totality ends at $8^h\ 30^m$, and at $9^h\ 41^m$ the moon has regained its usual brightness." —A. L. P.

The observed times of a lunar eclipse are readily checked by comparison with the Ephemeris, for differences in position on the earth in no-wise affect the actual time of the beginning, ending or other phase; so when calculations have been made for any given place, Greenwich, for example, the problem involved is one that has already been considered in Lesson V. Thus, the central standard time at Fall River for the end of totality is the Greenwich time, May, $2^d\ 14^h\ 27^m$ minus $6^h$, or May, $2^d\ 8^h\ 27^m$, P. M., differing three minutes from the observed time, given by the watch.

The window gnomon where the image of the sun takes the place of the shadow has been mentioned more than once, and reference is made to it again for more detailed treatment because it possesses so many points of advantage. Not that it is in any way radically new. Anaximander and other ancient astronomers left little to be discovered about the simple gnomon.

For the form considered here, it may be said that it takes little room, costs little, is ready for use whenever the sun shines, and affords facilities for twenty or more to carry on observations without seriously interfering with one another. For it, the stock arguments against the practical study of elementary astronomy break down completely. It does not disturb the usual routine, makes no inroads on study hours, calls for no inconvenient journeying about, no nightly vigils; and yet with its help two of the three large problems of practical astronomy that touch most closely our daily life are easily solved, for the simplest of observations give latitude and time.

It would seem also to offer means, if indeed any are available, to combat the almost contemptuous indifference to direct study of the heavens. How dominant this attitude is has lately been brought vividly to mind by a letter from a former student of mine, now a teacher of mathematics in one of the high schools of New York City. This is what she writes: "One day last winter the sun shone into my schoolroom through a thin bank of clouds so that one could easily see its shape, and I called to my class to look and see what shape it was. Most of them thought it not worth while to look out. They had learned from a book in the grammar school that it is round." —L. C. H.

Would it not tend to awaken scientific curiosity, if boys and girls were allowed to play with a solar-image gnomon? Would it not bring light into some of the dark places in arithmetic and geography, if they found how much the schoolroom clock was fast or slow, and how far the building stood north of the equator?

An illustration of this gnomon is given in Fig. 5, and is based on an original drawing of one placed in the lecture room of the Kansas University Observatory. The lower sash, *WD*, is shown, and sunlight falling on it during the middle of the day passes through the nearly circular aperture, *O*, and forms bright, oval images on the projecting board, *BD*. The height of the aperture above the board should be as large as possible, seldom less than twenty inches. Its size may vary somewhat with the season of the year and the observer's preference, but a diameter of about $\frac{3}{8}$ of an inch usually gives a satisfactory image that is clearly defined. The aperture should be cut in dark, unglazed paper, thoroughly soaked in water before it is pasted on the glass, a precaution that will appeal to those who, after patient waiting for the clear shining of the sun, right in the midst of a series of observations, have seen the precious bit of paper drop off; for to put it back

again rivals the task that balked "all the king's horses and all the king's men" in the nursery rhyme of Humpty Dumpty.

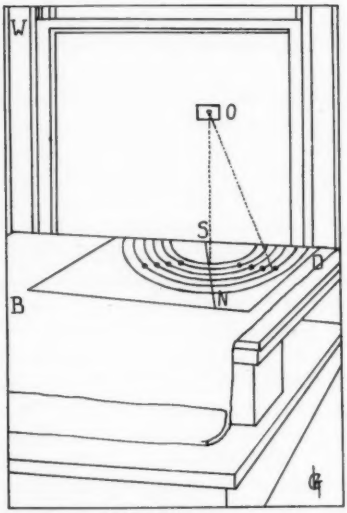



Figure 5.

The projecting board, 2 ft. by 3½ ft., was supported on a large heavy table, close to the window, and, at either end of the longer side, was cut away so that it rested on the lower frame of the window sash, coming flush with the glass. On the opposite side it was "leveled up" by a pile of narrow boards with thin strips of pasteboard for final adjustment, as tested by a carpenter's level. Since the board, made of hard pine, was uneven from warping, in spite of cleats on the under side, it was first covered with heavy enamel cloth, and over that was laid a sheet of white drawing paper.

Hardly any two projecting boards will be just alike. After the north and south line is drawn, one that is smooth, painted white, and required only for a few observers needs no covering of paper or cloth. The size will naturally vary with the number and character of observations to be made, and means of support will differ according to different conditions. A small board may rest securely on large brackets, fastened to the window frame on either side, and one of almost any size can be made the top of a table, adapted in height and shape to the window to be employed. Whatever the method, provision must be made for readjustment in level. There are those who appear to think if a projecting board is once leveled, nothing more is needed. Alas, they know little of leveling. Even a level board by a carpenter's standard, can be had only at the price of liberty, eternal vigilance.

Little use can be made of any gnomon without a north and south line, and this line, drawn, as it is, on the projecting board, is a part almost of our window gnomon. Two points, of course, determine its position, and one of them is to be taken at *S*, the foot of the vertical line passing centrally through *O;* for the plane of the required meridian must contain *OS*, so that when the sun crosses the celestial meridian in the heavens, its image is bisected by the meridian line, *SN*. Merely aligning downward by the eye from the center of *O* gives the point *S*, approximately, but it is obtained more accurately by some such method as the following, employed in determining *NS*.

After the meridian line has been located roughly by a trial observation, a slender, brass plumb bob is suspended from the upper frame of *WD* by a small cord passed through the slot in a thumb tack, so placed that the cord is brought over the aperture. That it may pass centrally across, as sighted in the meridian plane, usually calls for further adjustment by slightly shifting the tack to the right and left. Since the bob itself takes up room, the point *S* is not that just below the bob, to reach it, the latter point is carried southward a little in the direction of the meridian, by a space just equal to that between the glass and the plumb line at the center of the aperture. The fact that the "direction" is not known exactly should introduce no appreciable error, as the distances considered are very small. Note that *S* is not necessarily in the plane of the glass, for that would imply that the sash is perfectly plumb.

The crucial part of the problem lies in finding a second point, and one method, that employed here and entirely independent of Ephemeris and time-piece, is outlined as follows:

A number of concentric arcs having been described on the sheet of drawing paper mentioned, it is replaced on the projecting board with the center of arcs coinciding with point *S*, and fastened down securely with thumb tacks. Observations come next, and on a clear morning, beginning about eleven o'clock, the solar image is watched as it appears on the west side of the board, moving toward the south. Just as its center crosses the second arc, reckoned from the north, Fig. 5, that point is marked, and in like manner points are fixed when the three succeeding arcs are crossed. Observing is then suspended for rather more than an hour, for near apparent noon, the south and north motions of the image are so slow that accurate bisections are hardly possible. In the afternoon when the image going northward crosses these same arcs again, dots are made as its center reaches each in turn. Of course, in deciding on the instant of bisection, no reference is made to watch or clock. The moving image is the sole and only guide.

These insignificant little dots, the centers of the ovals shown in Fig. 5, hold the key to our problem. For a moment let attention center on the first and last, called for convenience *I* and *I'*. It is evident that *SIO SI'O* give the sun's altitude (Lesson VI, Fig. 2), but as the two tri-

angles are equal, the altitudes are equal; and that means, neglecting the slight motion in declination in a few hours, that when its image was at $I$ and $I'$, the sun was equally distant from the meridian and on opposite sides of it. Therefore, the middle point on the chord $II'$ fixes quite accurately the second point required. The middle points on the three other arcs are also found, and through the mean position of the four and the first point $S$, the north and south line, $NS$ is drawn, August 2.

To secure an independent check for the work, another line was obtained in like manner on the following day, but it was found to coincide with the first, as far along its length as a meridian can be used at this time of year. Both lines also met the test that points derived from different arcs should vary little in an east and west direction, the extreme differences on either day being hardly more than 1/32 of an inch.

All observations with this gnomon are made by noting the position of the solar image. Thus, to find the error of a watch, we read the hour, minute and second, at just the instant when the image is bisected by the meridian; to determine latitude, the center of the image is marked as it crosses the same line; and to locate a diurnal path of the sun, a number of positions, including that on the meridian and one as far east or west as possible, are fixed at intervals of about an hour.

Regarding lines to be measured and other details of reduction, full explanations, with one exception, have been given in the preceding lesson. In obtaining positions of the sun, however, altitudes alone do not suffice, azimuths must also be known. To find them, place a large semicircular protractor on the projecting board with its center at $S$, and read the angular distance of each point from the meridian (Byrd's First Observations, § 31).

The first test of this gnomon in actual use was given by two determinations of latitude which differed by 4 and 17 minutes of arc from the standard value of the observatory; and yet neither these errors, nor any within 30′, if made by inexperienced beginners, should be condemned as unsatisfactory. True, they are large compared with those of Tycho Brahe, the great observational astronomer before the era of telescopes, but rude home-made appliances are by no means in the same class as that astronomer's extensive and costly instrumental equipment for the work of a permanent observatory. Our unpretentious altazimuths, gnomons, and sundials should not be taken too seriously. They are designed only as temporary aids in first study of the heavens, and serve their purpose if they give something of an insight into the scientist's method of working, and afford means for solving some of the fundamental problems of astronomy.

A gnomon like that which has been described accommodates a far larger number if it is provided with several "paper apertures" and corresponding meridian lines. After these lines are drawn, whether

there are one or more, it will be found convenient to have the sheet with concentric arcs removed, pains having of course been taken to transfer the lines to the surface below.

The directions in the following exercises, though explicit, admit of not a few modifications.

TOPICS FOR LESSON VII.

1. Make a projecting board, out of soft pine, if practicable, and let it be well braced by cleats on the under side.

2. Having placed the board in position and leveled it, find how near the central line of the window and how high up the paper with its aperture should be pasted that it may give a clearly defined image of the sun, placed satisfactorily on the board.

3. Paste the small piece of paper on the glass, and by means of a plumb line with slender bob, locate the point, *S*, on the board, vertically below the center of the aperture.

4. Describe a number of concentric arcs on a sheet of drawing paper or tracing cloth, and adjust it on the board with the center of arcs coinciding with *S*, the first point in the meridian line.

5. On a thoroughly clear day follow the course of the sun's image, and mark its center, as it comes to three or four arcs, when moving down in the morning; and in the afternoon, as the image moves upward, fix the center as it again crosses the same arcs.

6. Find the middle points, on the chords connecting each pair of dots, thus locating several positions for the second point in the meridian.

7. Through *S* and the mean position of the second point, draw the meridian line, and then use it in taking an observation to determine the latitude of the observing station.

8. Employ the gnomon in finding the error of a watch or clock.

9. With the same gnomon, obtain data for locating an October path of the sun.

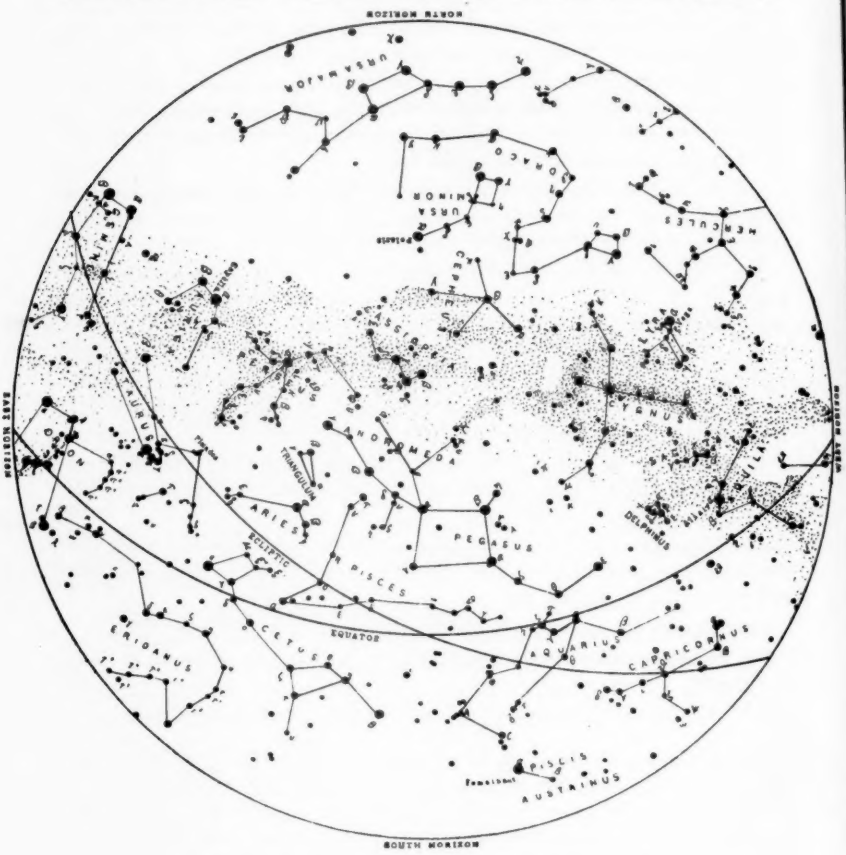
10. Derive the altitude and azimuth of each point fixed above.

October is the ideal month of the year for observing the heavens at night, and doubtless few will neglect moon, planets, and stars, even though the formal topics of this lesson are devoted to the sun. Perhaps this month it will still be possible to watch the new star in Cygnus, at least with opera-glasses.

Route 9, Box 77, Lawrence, Kansas.

## PLANET NOTES FOR NOVEMBER, 1920.

On the morning of the tenth there will be a partial eclipse of the *Sun* visible over a great part of North America, the North Atlantic, Western Europe and Northern Africa. The eclipse begins at 7:47 A. M. and ends at 11:57 A. M. Central Standard Time. Diagrams concerning the eclipse having been published




THE CONSTELLATIONS AT 9:00 P. M. NOVEMBER 1.

in the last number of POPULAR ASTRONOMY no further description is necessary.

The phases of the *Moon* occur as follows:

| | | | | | |
|---|---|---|---|---|---|
| Last Quarter | November | 3 | at | 1:35 A.M. | C.S.T. |
| New Moon | | 10 | " | 10:05 A.M. | " |
| First Quarter | | 18 | " | 2:13 P.M. | " |
| Full Moon | | 25 | " | 5:42 P.M. | " |

*Mercury* is not well placed for observation during the month, although it may be possible to get a glimpse toward the end of November. At that time the planet will be approaching western elongation and may possibly be detected at a low altitude before sunrise. The planet is at inferior conjunction on the fifteenth and at perihelion on the nineteenth.

*Venus* will be visible in the southwest after sunset, her distance from the sun gradually increasing during the month. She will reach aphelion on the tenth. On the thirteenth Venus will be in conjunction with the moon but 5° 35′ south of the latter. For a period of several months the planet will be visible to the unaided eye in the daytime.

*Mars* will also be found in the southwest after sunset but will not be very conspicuous as his distance from the earth is rapidly increasing. On the first this distance will be 144 millions of miles and on the thirtieth 158 millions. Thus Mars is receding from us at a rate of nearly 500,000 miles a day.

*Jupiter* is a morning star rising some hours before the sun and well placed for observation before daylight. On the fifth Jupiter will be in conjunction with the moon but 5° 30′ north of our satellite. On the morning of the sixth the four large moons of the great planet will all be grouped on the eastern side of their primary. It would be interesting to watch their relative motions at this time with any instrument large enough to show them.

*Saturn* will be found in the constellation Leo about 8° east of Jupiter and therefore also well placed for telescopic observation before sunrise. On the morning of the sixth Saturn, Jupiter and the crescent moon will form a triangle with sides about 5°, 8°, and 10° in length. On November seventh the earth will pass through the plane of Saturn's rings. For some days preceding and following this date the rings will probably be invisible in small telescopes. It would be interesting to obtain information on this point and see how the time of disappearance and reappearance is dependent on the aperture of the instrument used.

*Uranus* remains in Aquarius as during the preceding months of the year. Quadrature occurs on the twenty-fourth.

*Neptune* is at quadrature on the sixth, stationary on the sixteenth and will be in conjunction with the moon on the third and on the thirtieth. At both conjunctions the planet will be somewhat over 5° from the moon's center.

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## Occultations Visible in the United States, November, 1920

[NOTE:—Geographical positions are indicated by giving for each point, first the latitude, then the longitude, the two being separated by a hyphen. A line drawn on a map through the two or more points thus indicated will mark approximately the limit of the region of visibility for the United States.

The time given is the approximate Greenwich time of the middle of the occultation as seen from the United States.]

Nov. 2, $16^h$. $A^3$ Cancri, Mag. 5.7. East of 50°-91°, 38°-87°, 25°-80°.

Nov. 2, $21^h$. 60 Cancri, Mag. 5.7. South of 47°-126°, 49°-105°, 48°-80°, 46°-65°.

Nov. 8, $3^h$. α Virg., Mag. 1.2. North of 44°-125°, 38°-111°, 30°-94°, 22°-81°.

Nov. 12, $11^h$. 109 B. Oph., Mag. 6.2. East of 50°-112°, 43°-105°, and north of 43°-105°, 50°-89°. (Farther west, occurs before sunset.)

Nov. 16, $10^h$. 16 B. Cap., Mag. 6.2. East of 50°-91°, 38°-85°, 24°-80°. (Farther west, occurs before sunset.)

Nov. 16, 10h. β Cap., Mag. 3.2. East of 50°-94°, 38°-88°, 24°-83°. (Farther west, occurs before sunset.)

Nov. 16, 17h. 45 B. Cap., Mag. 6.1. West of 50°-119°, 40°-115°, 30°-114°.

Nov. 17, 11h. ρ Aquarii, Mag. 4.5. Southeast of 36°-90°, 42°-79°, 48°-69°, and east of long. 90°. (Farther west, occurs before sunset.)

Nov. 19, 19h. 6 G. Psc., Mag. 6.2. West of 50°-101°, 40°-100°, 28°-103°.

Nov. 20, 18h. λ Psc., Mag. 4.6. South of 31°-113°, 35°-96°, 37°-75°.

Nov. 24, 10h. 145 B. Ariet., Mag. 6.5. South of 40°-80, 43°-70°, and east of long. 80°. (Farther west, occurs after sunset.)

Nov. 25, 16h. 85 $H^1$. Tauri, Mag. 6.0. South of 31°-118°, 37°-103°, 43°-84°, 45°-66°.

Nov. 25, 18h. 234 B. Tauri, Mag. 6.0. South of 31°-108°, 33°-90°, 32°-75°.

Nov. 26, 3h. 302 B. Tauri, Mag. 6.1. West of 40°-126°, 50°-116°. (Farther east, occurs after sunrise.)

Nov. 27, 23h. 26 Gem., Mag. 5.2. North of 48°-125°, 45°-109°, 38°-90°, 32°-76°.

Nov. 28, 17h. 68 Gem., Mag. 5.2. North of 40°-127°, 44°-106°, 47°-83°.

Nov. 29, 17h. 84 B. Cancri, Mag. 6.4. South of 37°-124°, 40°-108°, 42°-90°, 43°-70°.

Nov. 29, 22h. $A^1$ Cancri, Mag. 5.5. South of 42°-128°, 40°-113°, 35°-95°, 26°-77°.

Nov. 30, 1h. $A^2$ Cancri, Mag. 5.7. Southwest of 50°-100°, 44°-87°, and west of 44°-87°, 28°-93°. (Farther east, occurs after sunrise.)

Nov. 30, 17h. ω Leonis, Mag. 5.5. East of 50°-113°, 40°-107°, 30°-98°, and north of 30°-98°, 31°-88°, 32°-76°.

ARTHUR SNOW,
Ass't. Nautical Almanac Office, U. S. Naval Observatory.

## VARIABLE STARS.

### Maxima of Variable Stars of Short Period.

[Calculated by members of the class in General Astronomy at Carleton College.]

Given to the nearest hour in Greenwich mean time; to obtain Eastern Standard time subtract 5h; Central Standard time 6h, etc.

| Star | R.A. 1900 | Decl. 1900 | Magnitude | Approx. Period | Greenwich mean times of maxima in 1920 November | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | h m | ° ′ | | d h | d h | d h | d h | d h | d h | d h |
| SX Cassiop. | 0 05.5 | +54 20 | 8.6— 9.2 | 36 13.7 | | | | | | |
| SY Cassiop | 0 09.8 | +57 52 | 9.3— 9.9 | 4 1.7 | 3 15 | 11 19 | 19 22 | 28 1 | | |
| RR Ceti | 1 27.0 | + 0 50 | 8.3— 9.0 | 0 13.3 | 4 12 | 13 6 | 20 0 | 27 17 | | |
| RW Cassiop. | 1 30.7 | +57 15 | 8.9—11.0 | 14 19.2 | | 13 3 | | 27 22 | | |
| V Arietis | 2 09.6 | +11 46 | 8.3— 9.0 | 0 23.8 | 3 1 | 10 23 | 18 22 | 26 21 | | |
| SU Cassiop. | 2 43.0 | +68 28 | 6.5— 7.0 | 1 22.8 | 2 11 | 10 6 | 18 1 | 25 20 | | |
| TU Persei | 3 01.8 | +52 49 | 11.4—12.2 | 0 14.6 | 7 3 | 14 10 | 21 17 | 29 0 | | |
| RW Camelop. | 3 46.2 | +58 21 | 8.2— 9.4 | 16 00.0 | | 12 0 | | 28 0 | | |
| SX Persei | 4 10.2 | +41 27 | 10.4—11.2 | 4 07.0 | 4 5 | 12 19 | 21 9 | 29 23 | | |
| SV Persei | 42.8 | +42 07 | 8.8— 9.6 | 11 03.1 | 9 13 | | 20 17 | | | |
| RX Aurigæ | 4 54.5 | +39 49 | 7.2— 8.1 | 11 15.0 | | 11 13 | 23 4 | | | |
| SX Aurigæ | 5 04.6 | +42 02 | 8.0— 8.7 | 1 12.8 | 3 2 | 10 18 | 18 11 | 26 2 | | |
| SY Aurigæ | 05.5 | +42 41 | 8.4— 9.5 | 10 03.3 | | 9 4 | 19 7 | 29 10 | | |
| Y Aurigae | 21.5 | +42 21 | 8.6— 9.6 | 3 20.6 | 7 23 | 15 16 | 23 10 | | | |
| RZ Gemin. | 5 56.6 | +22 15 | 9.1—10.0 | 5 12.7 | 2 19 | 7 8 | 19 9 | 24 22 | | |
| RS Orionis | 6 16.5 | +14 44 | 8.2— 8.9 | 7 13.6 | 3 23 | 11 12 | 19 2 | 26 16 | | |
| T Monoc. | 19.8 | + 7 08 | 5.7— 6.8 | 27 00.3 | | | 24 12 | | | |
| RT Aurigæ | 23.0 | +30 33 | 5.1— 6.0 | 3 17.5 | 2 8 | 9 19 | 17 6 | 24 17 | | |
| RZ Camelop. | 23.7 | +67 06 | 11.0—13.0 | 0 11.5 | 2 1 | 9 6 | 16 11 | 23 16 | | |
| W Gemin. | 29.2 | +15 24 | 6.7— 7.5 | 7 22.0 | 2 0 | 9 22 | 17 20 | 25 17 | | |
| ζ Gemin. | 6 58.2 | +20 43 | 3.7— 4.3 | 10 03.7 | 3 6 | 13 10 | 23 14 | | | |
| RU Camelop. | 7 10.9 | +69 51 | 8.5— 9.8 | 22 06.5 | 1 18 | | 24 1 | | | |
| RR Gemin. | 7 15.2 | +31 04 | 10.0—11.5 | 0 09.5 | 2 15 | 10 14 | 18 12 | 26 11 | | |

**Maxima of Variable Stars of Short Period—Continued.**

| Star | R.A. 1900 | Decl. 1900 | Magnitude | Approx. Period | Greenwich mean times of maxima in 1920 November | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | h m | ° ′ | | d h | d h | d h | d h | d h | d h | d h | d h | d h |
| V Carinæ | 8 26.7 | −59 47 | 7.4— 8.1 | 6 16.7 | 3 10 | 10 3 | 16 19 | 23 12 | | | | |
| T Velorum | 8 34.4 | −47 01 | 7.6— 8.5 | 4 15.3 | 2 1 | 11 8 | 20 15 | 29 22 | | | | |
| V Velorum | 9 19.2 | −55 32 | 7.5— 8.2 | 4 08.9 | 6 18 | 15 12 | 24 6 | | | | | |
| Z Leonis | 9 46.4 | +27 22 | 7.9— 9.6 | 59 00.0 | | | | | | | | |
| RR Leonis | 10 02.1 | +24 29 | 9.1—10.1 | 0 10.9 | 6 0 | 12 19 | 19 13 | 26 8 | | | | |
| SU Draconis | 11 32.2 | +67 53 | 8.9— 9.6 | 0 15.8 | 7 0 | 13 14 | 20 5 | 26 19 | | | | |
| S Muscæ | 12 07.4 | −69 36 | 6.4— 7.3 | 9 15.8 | 9 22 | 19 13 | 29 5 | | | | | |
| SW Draconis | 12.8 | +70 04 | 8.8— 9.6 | 0 13.7 | 3 12 | 11 11 | 19 11 | 27 10 | | | | |
| T Crucis | 15.9 | −61 44 | 6.8— 7.6 | 6 17.6 | 6 17 | 13 10 | 20 12 | 26 22 | | | | |
| R Crucis | 18.1 | −61 04 | 6.8— 7.9 | 5 19.8 | 5 16 | 11 11 | 23 3 | 28 23 | | | | |
| S Crucis | 12 48.4 | −57 53 | 6.5— 7.6 | 4 16.6 | 4 22 | 9 15 | 19 0 | 23 16 | | | | |
| W Virginis | 13 20.9 | − 2 52 | 8.7—10.4 | 17 06.5 | | 10 3 | | 27 9 | | | | |
| SS Hydræ | 25.0 | −23 08 | 7.4— 8.1 | 8 04.8 | 6 0 | 14 5 | 22 10 | 30 15 | | | | |
| RV Urs. Maj. | 13 29.4 | +54 31 | 9.2— 9.9 | 0 11.2 | 6 15 | 13 16 | 20 16 | 27 17 | | | | |
| ST Virginis | 14 22.5 | − 0 27 | 10.3—11.4 | 0 09.9 | 5 19 | 14 1 | 22 6 | 30 11 | | | | |
| V Centauri | 25.4 | −56 27 | 6.4— 7.8 | 5 11.9 | 5 15 | 11 3 | 22 3 | 27 14 | | | | |
| RS Bootis | 29.3 | +32 11 | 8.9—10.0 | 0 09.1 | 5 17 | 13 6 | 20 19 | 28 8 | | | | |
| RU Bootis | 14 41.5 | +23 44 | 12.8—14.3 | 0 11.9 | 3 12 | 10 22 | 18 7 | 25 18 | | | | |
| R Triang. Austr. | 15 10.8 | −66 08 | 6.7— 7.4 | 3 09.3 | 5 0 | 11 19 | 18 14 | 25 9 | | | | |
| S Triang. Austr. | 15 52.2 | −63 29 | 6.4— 7.4 | 6 07.8 | 1 2 | 7 10 | 20 2 | 26 9 | | | | |
| S Normæ | 16 10.6 | −57 39 | 6.6— 7.6 | 9 18.1 | 7 10 | 17 4 | 26 22 | | | | | |
| RW Draconis | 33.7 | +58 03 | 9.6—10.8 | 0 10.6 | 4 23 | 13 19 | 22 16 | | | | | |
| RV Scorpii | 16 51.8 | −33 27 | 6.7— 7.4 | 6 01.5 | 5 2 | 11 4 | 23 14 | 29 16 | | | | |
| X Sagittarii | 17 41.3 | −27 48 | 4.4— 5.0 | 7 00.3 | 5 16 | 12 16 | 19 16 | 26 16 | | | | |
| Y Ophiuchi | 47.3 | − 6 07 | 6.1— 6.5 | 17 02.9 | 1 12 | | 18 15 | | | | | |
| W Sagittarii | 17 58.6 | −29 35 | 4.3— 5.1 | 7 14.3 | 4 9 | 11 23 | 19 14 | 27 4 | | | | |
| Y Sagittarii | 18 15.5 | −18 54 | 5.4— 6.2 | 5 18.6 | 5 2 | 10 21 | 22 10 | 28 5 | | | | |
| U Sagittarii | 26.0 | −19 12 | 6.5— 7.3 | 6 17.9 | 1 19 | 8 13 | 22 0 | 28 18 | | | | |
| Y Scuti | 32.6 | − 8 27 | 8.7— 9.2 | 10 08.3 | 10 7 | | 20 15 | | | | | |
| Y Lyræ | 34.2 | +43 52 | 11.3—12.3 | 0 12.1 | 2 1 | 8 2 | 20 4 | 26 4 | | | | |
| RZ Lyræ | 18 39.9 | +32 42 | 9.9—11.2 | 0 12.3 | 5 12 | 11 15 | 23 22 | 30 1 | | | | |
| RT Scuti | 44.1 | −10 30 | 9.1— 9.7 | 0 11.9 | 6 22 | 12 21 | 24 18 | 30 17 | | | | |
| κ Pavonis | 18 46.6 | −67 22 | 3.8— 5.2 | 9 02.2 | | 10 0 | 19 2 | 28 4 | | | | |
| U Aquilæ | 19 24.0 | − 7 15 | 6.2— 6.9 | 7 00.6 | 1 17 | 8 18 | 22 19 | 29 20 | | | | |
| XZ Cygni | 30.4 | +56 10 | 8.6— 9.3 | 0 11.2 | 2 19 | 9 19 | 23 19 | 30 19 | | | | |
| U Vulpec. | 32.2 | +20 07 | 6.5— 7.6 | 7 23.5 | 6 4 | 14 3 | 22 3 | | | | | |
| SU Cygni | 40.8 | +29 01 | 6.2— 7.0 | 3 20.3 | 3 10 | 11 2 | 18 19 | 26 11 | | | | |
| η Aquilæ | 47.4 | + 0 45 | 3.7— 4.5 | 7 04.2 | 6 3 | 13 7 | 20 11 | 27 16 | | | | |
| S Sagittæ | 51.5 | +16 22 | 5.6— 6.4 | 8 09.2 | 7 22 | 16 7 | 24 16 | | | | | |
| X Vulpec. | 19 53.3 | +26 17 | 9.5—10.5 | 6 07.7 | 4 1 | 10 8 | 22 23 | 29 7 | | | | |
| X Cygni | 20 39.5 | +35 14 | 6.0— 7.0 | 16 09.3 | | 14 15 | | | | | | |
| T Vulpec. | 47.2 | +27 52 | 5.5— 6.1 | 4 10.5 | 3 6 | 12 2 | 20 23 | 29 21 | | | | |
| WY Cygni | 52.3 | +30 03 | 9.6—10.4 | 0 13.5 | 6 15 | 13 8 | 20 2 | 26 19 | | | | |
| RV Capric. | 55.9 | −15 37 | 9.2—10.1 | 0 10.7 | 2 6 | 9 0 | 22 10 | 29 3 | | | | |
| TX Cygni | 20 56.4 | +42 12 | 8.5— 9.7 | 14 17.4 | 9 19 | | 24 13 | | | | | |
| VY Cygni | 21 00.4 | +39 34 | 8.8— 9.5 | 7 20.6 | 5 18 | 13 15 | 21 12 | 29 8 | | | | |
| SW Aquarii | 10.2 | − 0 20 | 9.9—10.8 | 0 11.0 | 6 9 | 13 10 | 19 23 | 26 20 | | | | |
| VZ Cygni | 21 47.7 | +42 40 | 8.2— 9.2 | 4 20.7 | 1 14 | 11 7 | 21 1 | 30 18 | | | | |
| Y Lacertæ | 22 05.2 | +50 33 | 9.1— 9.6 | 4 07.8 | 4 5 | 12 21 | 21 12 | 30 4 | | | | |
| δ Cephei | 25.5 | +57 54 | 3.7— 4.6 | 5 08.8 | 4 5 | 9 14 | 20 7 | 25 16 | | | | |
| Z Lacertæ | 36.9 | +56 18 | 8.2— 9.0 | 10 21.1 | 2 15 | 13 12 | 24 9 | | | | | |
| RR Lacertæ | 37.5 | +55 55 | 8.5— 9.2 | 6 10.1 | 3 3 | 9 13 | 17 0 | 22 10 | | | | |
| V Lacertae | 44.5 | +55 48 | 8.5— 9.5 | 4 23.6 | 2 20 | 12 19 | 22 18 | 27 18 | | | | |
| X Lacertæ | 22 45.0 | +55 54 | 8.2— 8.6 | 5 10.7 | 1 16 | 12 13 | 23 11 | 28 21 | | | | |
| SW Cassiop. | 23 03.7 | +58 11 | 9.2— 9.7 | 5 10.6 | 5 12 | 10 22 | 21 19 | 27 6 | | | | |
| RS Cassiop. | 32.6 | +61 52 | 9.0—11.0 | 6 07.1 | 5 13 | 11 20 | 24 11 | 30 17 | | | | |
| RY Cassiop. | 47.2 | +58 11 | 9.3—11.8 | 12 03.4 | | 7 20 | 19 23 | | | | | |
| V Cephei | 23 51.7 | +82 38 | 6.0— 7.0 | 0 23.9 | 5 8 | 12 8 | 19 7 | 26 7 | | | | |

## Minima of Variable Stars of Short Period.

[Calculated by members of the class in General Astronomy at Carleton College.]

Given to the nearest hour in Greenwich mean time; to obtain Eastern Standard time subtract 5$^h$; Central Standard time 6$^h$, etc.

| Star | R.A. 1900 | Decl. 1900 | Magnitude | Approx. Period | Greenwich mean times of minima in 1920 November | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | h m | ° ′ | | d h | d h | d h | d h | d h | d h | d h | d h | d h |
| SY Androm. | 0 08.0 | +43 09 | 9.5—13.0 | 34 21.8 | | | | | 19 17 | | | |
| RT Sculptor. | 31.5 | —26 13 | 9.6—10.5 | 0 12.3 | 1 2 | 8 18 | 16 10 | 24 3 | | | | |
| UU Androm | 38.5 | +30 24 | 10.7—11.9 | 1 11.7 | 7 16 | 15 3 | 22 13 | 29 23 | | | | |
| U Cephei | 0 53.4 | +81 20 | 7.0— 9.0 | 2 11.8 | 6 17 | 14 4 | 21 16 | 29 3 | | | | |
| Z Persei | 2 33.7 | +41 46 | 9.4—12 | 3 01.4 | 7 3 | 13 5 | 19 8 | 25 11 | | | | |
| TW Cassiop. | 37.6 | +65 19 | 8.2— 9.0 | 1 10.3 | 4 2 | 11 5 | 18 8 | 25 12 | | | | |
| RY Persei | 39.0 | +47 43 | 8.0—10.3 | 6 20.7 | 1 0 | 7 21 | 21 14 | 28 11 | | | | |
| RZ Cassiop. | 39.9 | +69 13 | 6.9— 8.1 | 1 04.7 | 7 1 | 14 5 | 21 9 | 28 13 | | | | |
| TX Cassiop. | 44.4 | +62 22 | 9.4—10.1 | 2 22.2 | 5 16 | 14 11 | 23 6 | | | | | |
| ST Persei | 53.7 | +38 47 | 8.5—10.5 | 2 15.6 | 5 23 | 13 22 | 21 20 | 29 19 | | | | |
| RX Cassiop. | 2 58.8 | +67 11 | 8.6— 9.1 | 32 07.6 | | | 20 6 | | | | | |
| Algol | 3 01.7 | +40 34 | 2.3— 3.5 | 2 20.8 | 2 8 | 8 2 | 19 13 | 25 7 | | | | |
| RT Persei | 16.7 | +46 12 | 9.5—11.5 | 0 20.4 | 3 22 | 10 16 | 17 12 | 24 7 | | | | |
| λ Tauri | 55.1 | +12 12 | 3.3— 4.2 | 3 22.9 | 8 9 | 13 6 | 24 4 | | | | | |
| RW Tauri | 3 57.8 | +27 51 | 7.1—<11 | 2 18.5 | 4 18 | 13 2 | 21 9 | 29 16 | | | | |
| RV Persei | 4 04.2 | +33 59 | 9.5—11.0 | 1 23.4 | 2 20 | 10 17 | 18 15 | 26 12 | | | | |
| RW Persei | 13.3 | +42 04 | 8.8—11.0 | 13 04.8 | 2 12 | 15 16 | 28 21 | | | | | |
| SZ Tauri | 31.4 | +18 20 | 7.2— 7.7 | 3 03.6 | 8 14 | 18 1 | 27 11 | | | | | |
| RS Cephei | 4 48.6 | +80 06 | 9.5—12.0 | 12 10.1 | 1 3 | 13 13 | 25 23 | | | | | |
| TT Aurigæ | 5 02.8 | +39 27 | 7.8— 8.7 | 0 16.0 | 1 4 | 8 15 | 21 23 | 28 15 | | | | |
| RY Aurigæ | 11.5 | +38 13 | 10.7—11.7 | 2 17.5 | 2 5 | 10 10 | 18 15 | 26 19 | | | | |
| RZ Aurigæ | 42.9 | +31 40 | 10.6—13.3 | 3 00.3 | 5 14 | 11 14 | 23 16 | 29 16 | | | | |
| SV Tauri | 45.8 | +28 05 | 9.4—11.0 | 2 04.0 | 6 18 | 15 10 | 24 2 | | | | | |
| Z Orionis | 50.2 | +13 40 | 9.7—10.7 | 5 04.9 | 7 0 | 17 10 | 27 20 | | | | | |
| SV Gemin. | 54.6 | +24 28 | 9.8—<11 | 4 00.2 | 8 10 | 16 10 | 24 11 | | | | | |
| RW Gemin. | 5 55.4 | +23 08 | 9.5—11.0 | 2 20.8 | 3 11 | 9 4 | 20 15 | 26 9 | | | | |
| U Columbæ | 6 11.2 | —33 03 | 9.2—10.0 | 2 19.2 | 5 5 | 10 20 | 22 0 | 27 15 | | | | |
| SX Gemin. | 22.0 | +20 37 | 10.8—11.5 | 1 08.8 | 8 5 | 16 10 | 24 15 | | | | | |
| RW Monoc | 29.3 | + 8 54 | 9.0—10.8 | 1 21.7 | 7 10 | 15 1 | 22 16 | 30 7 | | | | |
| RX Gemin. | 43.6 | +33 21 | 8.8— 9.6 | 12 05.0 | 4 14 | 16 19 | 28 0 | | | | | |
| RU Monoc. | 6 49.4 | — 7 28 | 9.8—10.5 | 0 21.5 | 4 21 | 12 1 | 19 5 | 26 9 | | | | |
| R Can. Maj. | 7 14.9 | —16 12 | 5.8— 6.4 | 1 03.3 | 5 23 | 12 18 | 19 14 | 26 10 | | | | |
| RY Gemin. | 21.7 | +15 52 | 8.9—<10 | 9 07.2 | 8 16 | 18 0 | 27 6 | | | | | |
| Y Camelop. | 27.6 | +76 17 | 9.5—12 | 3 07.3 | 4 4 | 10 19 | 24 1 | 30 15 | | | | |
| TX Gemin. | 30.3 | +17 08 | 10.0—11.9 | 2 19.2 | 8 5 | 16 15 | 25 1 | | | | | |
| RR Puppis | 43.5 | —41 08 | 9.4—10.7 | 6 10.3 | 6 3 | 12 14 | 19 0 | 25 10 | | | | |
| V Puppis | 7 55.4 | —48 58 | 4.1— 4.8 | 1 10.9 | 6 9 | 13 16 | 20 23 | 28 5 | | | | |
| X Carinae | 8 29.1 | —58 53 | 7.9— 8.7 | 0 13.0 | 8 11 | 16 14 | 24 17 | | | | | |
| S Cancri | 8 38.2 | +19 24 | 8.2—10 | 9 11.6 | 5 23 | 15 11 | 24 22 | | | | | |
| RX Hydræ | 9 00.8 | — 7 52 | 9.1—10.5 | 2 6.8 | 3 5 | 10 2 | 23 18 | 30 14 | | | | |
| S Velorum | 29.4 | —44 46 | 7.8— 9.3 | 5 22.4 | 4 23 | 10 21 | 22 18 | 28 16 | | | | |
| Y Leonis | 9 31.1 | +26 41 | 9.3—11.2 | 1 16.5 | 4 21 | 11 15 | 18 8 | 25 2 | | | | |
| RR Velorum | 10 17.8 | —41 36 | 10.0—10.9 | 1 20.5 | 6 10 | 13 20 | 21 6 | 28 16 | | | | |
| SS Carinæ | 10 54.2 | —61 23 | 12.2—12.8 | 3 07.2 | 1 6 | 7 21 | 21 1 | 28 16 | | | | |
| ST Urs. Maj. | 11 22.4 | +45 44 | 6.7— 7.2 | 8 19.2 | 8 19 | 17 14 | 26 10 | | | | | |
| RW Urs. Maj. | 35.4 | +52 34 | 10.3—11.4 | 7 07.9 | 7 20 | 15 4 | 22 12 | 29 20 | | | | |
| Z Draconis | 11 39.8 | +72 49 | 9.9—13.6 | 1 08.6 | 1 13 | 8 8 | 21 22 | 28 17 | | | | |
| RZ Centauri | 12 55.6 | —64 05 | 8.5— 8.9 | 1 21.0 | 3 14 | 11 3 | 18 15 | 26 3 | | | | |
| RS Can. Ven. | 13 06.3 | +36 28 | 7.5—12.5 | 4 19.1 | 9 12 | 19 2 | 28 16 | | | | | |
| SS Centauri | 07.2 | —63 37 | 8.8—10.4 | 2 11.5 | 2 20 | 10 7 | 17 18 | 25 4 | | | | |
| *133926* Hydræ | 13 39.0 | —26 23 | 8.6—12.7 | 2 21.5 | 3 6 | 9 1 | 20 16 | 26 11 | | | | |
| δ Libræ | 14 55.6 | — 8 07 | 4.8— 6.2 | 2 07.9 | 6 21 | 13 21 | 20 20 | 27 20 | | | | |

**Minima of Variable Stars of Short Period**—Continued.

| Star | R.A. 1900 | Decl. 1900 | Magnitude | Approx. Period | Greenwich mean times of minima in 1920 November | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | h m | ° ′ | | d h | d h | d h | d h | d h | d h | d h |
| U Coronæ | 15 14.1 | +32 01 | 7.6— 8.7 | 3 10.9 | 1 13 | 8 11 | 22 6 | 29 4 | | |
| TW Draconis | 32.4 | +64 14 | 7.3— 8.9 | 2 19.3 | 7 8 | 15 18 | 24 4 | | | |
| SS Librae | 15 43.4 | —15 14 | 9.3—11.5 | 0 18.4 | 3 15 | 11 7 | 18 23 | 26 15 | | |
| SW Ophiuchi | 16 11.1 | — 6 44 | 9.2—10.0 | 2 10.7 | 3 8 | 10 16 | 18 0 | 25 8 | | |
| SX Ophiuchi | 12.6 | — 6 25 | 10.5—11.2 | 2 01.5 | 8 8 | 16 15 | 24 21 | | | |
| R Aræ | 31.1 | —56 48 | 6.8— 7.9 | 4 10.2 | 7 11 | 16 8 | 25 4 | | | |
| TT Herculis | 16 49.9 | +17 00 | 8.9— 9.3 | 20 18.1 | 7 5 | 18 7 | 28 0 | | | |
| TU Herculis | 17 09.8 | +30 50 | 9.5—12 | 2 06.4 | 2 3 | 8 23 | 22 13 | 29 8 | | |
| U Ophiuchi | 11.5 | + 1 19 | 6.0— 6.7 | 0 20.1 | 3 17 | 12 2 | 20 11 | 28 21 | | |
| *u* Herculis | 13.6 | +33 12 | 4.6— 5.4 | 2 01.2 | 3 1 | 9 5 | 21 12 | 27 16 | | |
| TX Herculis | 15.4 | +42 00 | 8.3— 9.0 | 1 00.7 | 6 21 | 13 2 | 19 6 | 25 10 | | |
| RV Ophiuchi | 29.8 | + 7 19 | 9. —12 | 3 16.5 | 4 4 | 11 13 | 18 22 | 26 7 | | |
| SZ Herculis | 36.0 | +33 01 | 9.5—10.3 | 0 19.6 | 5 18 | 13 23 | 22 3 | 30 7 | | |
| TX Scorpii | 48.6 | —34 13 | 7.5— 8.2 | 0 22.6 | 4 13 | 12 2 | 19 15 | 27 4 | | |
| UX Herculis | 49.7 | +16 57 | 8.8—10.5 | 1 13.2 | 5 22 | 13 16 | 21 10 | 29 4 | | |
| Z Herculis | 53.6 | +15 09 | 7.1— 7.9 | 3 23.8 | 4 1 | 12 0 | 20 0 | 28 0 | | |
| WX Sagittarii | 53.6 | —17 24 | 9.2—10.8 | 2 03.1 | 1 20 | 10 9 | 18 21 | 27 9 | | |
| WY Sagittarii | 17 54.9 | —23 1 | 9.5—10.6 | 4 16.0 | 8 6 | 17 14 | 26 22 | | | |
| SX Draconis | 18 03.0 | +58 23 | 9.3—10.5 | 5 04.1 | 3 15 | 13 23 | 24 7 | | | |
| RS Sagittarii | 11.0 | —34 08 | 5.9— 6.3 | 2 10.0 | 1 3 | 8 9 | 15 15 | 22 21 | | |
| V Serpentis | 11.1 | —15 34 | 9.5—11.1 | 3 10.9 | 6 12 | 13 10 | 20 8 | 27 5 | | |
| RZ Scuti | 21.1 | — 9 15 | 7.4— 8.3 | 15 03.2 | 6 13 | | 21 16 | | | |
| RZ Draconis | 21.8 | +58 50 | 9.5—10.2 | 0 13.2 | 3 6 | 10 10 | 17 14 | 24 18 | | |
| RX Herculis | 26.0 | +12 32 | 7.0— 7.6 | 0 21.3 | 5 4 | 12 7 | 19 10 | 26 12 | | |
| SX Sagittarii | 39.7 | —30 36 | 8.7— 9.8 | 2 01.8 | 4 22 | 13 6 | 21 13 | 29 20 | | |
| RR Draconis | 40.8 | +62 34 | 9.3—13 | 2 19.9 | 3 5 | 11 17 | 20 4 | 28 16 | | |
| RS Scuti | 43.7 | —10 21 | 9.3—10.3 | 0 15.9 | 3 14 | 10 5 | 16 21 | 23 12 | | |
| *β* Lyræ | 46.4 | +33 15 | 3.4— 4.1 | 12 21.8 | 9 5 | | 22 3 | | | |
| U Scuti | 18 48.9 | —12 44 | 9.1— 9.6 | 0 22.9 | 7 8 | 14 23 | 22 14 | | | |
| RX Draconis | 19 01.1 | +58 35 | 9.3—10.2 | 1 21.4 | 3 22 | 11 12 | 19 1 | 26 16 | | |
| RV Lyræ | 12.5 | +32 15 | 11. —12.8 | 3 14.4 | 4 2 | 11 7 | 18 11 | 25 16 | | |
| RS Vulpec. | 13.4 | +22 16 | 6.9— 8.0 | 4 11.4 | 9 22 | 18 21 | 27 20 | | | |
| U Sagittæ | 14.4 | +19 26 | 6.5— 9.0 | 3 09.1 | 5 1 | 11 19 | 18 13 | 25 8 | | |
| Z Vulpec. | 17.5 | +25 23 | 7.3— 8.5 | 2 10.9 | 4 4 | 11 13 | 18 21 | 26 6 | | |
| TT Lyræ | 24.3 | +41 30 | 9.4—11.6 | 5 05.8 | 3 20 | 9 2 | 19 14 | 24 20 | | |
| UZ Draconis | 26.1 | +68 44 | 9.0— 9.8 | 1 15.1 | 2 19 | 9 7 | 22 8 | 28 21 | | |
| SY Cygni | 19 42.7 | +32 28 | 10 —12 | 6 00.2 | 4 6 | 10 6 | 22 7 | 28 7 | | |
| WW Cygni | 20 00.6 | +41 18 | 9.3—13.4 | 3 07.6 | 2 9 | 9 0 | 22 7 | 28 22 | | |
| SW Cygni | 03.8 | +46 01 | 9. —11.7 | 4 13.8 | 9 18 | 18 22 | 28 1 | | | |
| VW Cygni | 11.4 | +34 12 | 9.8—11.8 | 8 10.3 | 8 16 | 17 2 | 25 12 | | | |
| RW Capric. | 12.2 | —17 59 | 8.8—10.6 | 3 09.4 | 6 11 | 13 5 | 20 0 | 26 19 | | |
| UW Cygni | 19.6 | +42 55 | 10.5—13 | 3 10.8 | 1 6 | 8 3 | 21 23 | 28 20 | | |
| V Vulpec. | 32.3 | +26 15 | 8.2— 9.8 | 37 19.0 | | 15 18 | | | | |
| W Delphini | 33.1 | +17 56 | 9.4—12.1 | 4 19.4 | | 10 1 | 19 16 | 29 6 | | |
| RR Delphini | 38.9 | +13 35 | 10.5—11.8 | 4 14.4 | 1 22 | 11 3 | 20 8 | 29 12 | | |
| Y Cygni | 48.1 | +34 17 | 7.1— 7.9 | 1 12.0 | 2 23 | 10 10 | 17 22 | 25 10 | | |
| WZ Cygni | 49.3 | +38 27 | 9.9—10.8 | 0 14.0 | 7 21 | 15 11 | 23 1 | | | |
| RR Vulpec. | 20 50.5 | +27 32 | 9.6—11.0 | 5 01.2 | 1 17 | 11 20 | 21 22 | | | |
| VVCygni | 21 02.3 | +45 23 | 12.1—13.8 | 1 11.4 | 3 7 | 10 16 | 18 1 | 25 10 | | |
| AE Cygni | 09.0 | +30 20 | 10.8—11.4 | 0 23.3 | 5 3 | 14 20 | 24 12 | | | |
| RY Aquarii | 14.8 | —11 14 | 8.8—10.4 | 1 23.2 | 6 12 | 14 9 | 22 6 | 30 3 | | |
| RT Lacertæ | 21 57.4 | +43 24 | 9.1—10.5 | 5 01.7 | 1 9 | 11 12 | 21 16 | | | |
| UZ Cygni | 55.2 | +43 52 | 8.9—11.6 | 31 07.3 | 1 15 | | | | | |
| RW Lacertæ | 22 40.6 | +49 08 | 10.2—11.2 | 5 04.4 | 5 5 | 10 9 | 20 18 | 25 22 | | |
| TT Androm. | 23 08.7 | +45 36 | 11.3—12.6 | 2 18.4 | 3 8 | 11 15 | 19 22 | 28 5 | | |
| Y Piscium | 29.3 | + 7 22 | 9.0—12.0 | 3 18.3 | 8 4 | 15 17 | 23 5 | 30 18 | | |
| TW Androm. | 23 58.2 | +32 17 | 8.6—11.5 | 4 02.9 | 6 21 | 15 2 | 23 8 | | | |

## NOTES FOR OBSERVERS.

### Monthly Report of the American Association of Variable Star Observers, June 20 to August 20, 1920

The appearance of Nova Cygni No. 3, 195653, is an event of great interest especially to the variable star observers, and the A.A.V.S.O. can feel proud of the fact that it was discovered independently in this country by Messrs. McAteer, Peltier, and Suter. This again calls our attention to the importance of a systematic effort being made to discover these objects as early as possible. Variable star observers should be in the best position to keep a systematic watch for novæ, and some plan such as was suggested several years ago should prove valuable if carefully followed. According to this plan the Milky Way is divided into areas covering two hours in Right Ascension and twenty degrees in Declination, each area being assigned to one or more observers. A person thoroughly familiar with such a region should have no difficulty in recognizing a newcomer among the stars. A few observations of Nova Cygni have been received, too late, however, for inclusion in this report.

We welcome seven new observers this month, as follows: Charles E. Barns, of Morgan Hill, Cal., a Patron of the Association; Professor A. Bemporad, Director of the Royal Observatory, Capodimonte, Naples, Italy, who is an honorary member of the Association; Howard Kaster, of Berkeley, Cal.; Donald H. Menzel, of Denver, Col.; John L. Peters, of East Holliston, Mass.; Herbert G. Rich, of Evanston, Ill.; and George C. Thompson, of Hudson, N. H. Professor Bemporad sends two splendid lists of observations made with a Keil photometer attached to a 7-inch refractor; the observations of R Leonis, 094211, are included herewith, and those of T Monocerotis will be combined with similar observations made at the Harvard College Observatory and published later.

The Council, which held a meeting at Mt. Holyoke College at the time of the meeting of the A.A.S., has elected the following to active membership:

| | |
|---|---|
| Harold L. Alden, | University of Virginia, Charlottesville, Va. |
| Professor K. P. Brooks, | Mt. Pleasant, Mich. |
| Mr. Frank J. Carr, | Swanton, Vermont. |
| Mr. H. L. Gernant, | Kalamazoo, Mich. |
| Dr. P. C. Irwin, | Seattle, Wash. |
| Sr. A. Llorens, | Barcelona, Spain. |
| Mr. W. E. Johnson, | Chicago, Ill. |
| Mr. Maynard F. Jordan, | Orono, Me. |
| Mr. F. Kerr, | Alexandria, Ont., Canada. |
| Mr. Fred F. Pitts, | Omaha, Neb. |
| Mr. Albert E. Schwartz, | Cincinnati, O. |
| Professor A. P. Saunders, | Hamilton College, Clinton, N. Y. |
| Miss L. E. Spaulding, | Blackfoot, Ia. |
| Rev. W. C. Taylor, | Martinsburg, W. Va. |
| Professor S. D. Townley, | Stanford University, Palo Alto, Cal. |

This brings the membership of the Association to 200. Every opportunity is before us to do scientific work commensurate with our numbers. In the last report the name of H. J. Long was erroneously published in place of Mr. H. J. Lacy, a new member of Owingsville, Ky.

VARIABLE STAR OBSERVATIONS, June 20 to August 20, 1920.

| Number | Name | J.D. | Est. | Obs. | J.D. | Est. | Obs. | J.D. | Est. | Obs. | J.D. | Est. | Obs. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 001046 | X Androm. | 2523.7 | *15.0* | M. | | | | | | | | | |
| *001620* | T Ceti | 2525.6 | 6.4 | L. | | | | | | | | | |
| 001726 | T Androm. | 2467.4 | 8.6 | Ch, | 2519.5 | 11.0 | Ja, | 2522.8 | 11.5 | Pt, | 2523.7 | 11.1 | M, |
| | | 2532.8 | 11.9 | Pt. | | | | | | | | | |
| 001755 | T Cassiop. | 2500.8 | 11.1 | M, | 2523.4 | 11.5 | L, | 2536.0 | 11.8 | Ml. | | | |
| 001838 | R Androm. | 2500.8 | *11.6* | M, | 2519.5 | *13.2* | Ja. | | | | | | |
| *001909* | S Ceti | 2522.8 | 12.2 | Pt, | 2523.8 | 11.8 | M, | 2525.6 | 12.2 | L. | | | |
| 003179 | Y Cephei | 2500.8 | 9.4 | M, | 2532.8 | 10.2 | M. | | | | | | |
| 004047 | U Cassiop. | 2499.8 | 10.0 | Pt, | 2500.8 | 9.5 | M, | 2532.8 | 12.4 | M. | | | |
| 004132 | RW Androm. | 2519.5 | 12.8 | Ja. | | | | | | | | | |
| 004435 | V Androm. | 2550.8 | 12.3 | M. | | | | | | | | | |
| 004533 | RR Androm. | 2518.8 | *10.8* | M, | 2550.8 | 12.3 | M. | | | | | | |
| 004746a | RV Cassiop. | 2502.8 | 9.8 | M. | | | | | | | | | |
| 004958 | W Cassiop. | 2499.8 | 11.5 | Pt, | 2523.8 | 11.2 | M, | 2546.6 | 10.1 | Pt. | | | |
| 010940 | U Androm. | 2518.8 | 10.1 | M, | 2519.5 | 9.9 | Ja. | 2554.8 | 10.4 | M. | | | |
| 011041 | UZ Androm. | 2518.8 | 10.8 | M, | 2554.8 | *11.0* | M. | | | | | | |
| 011208 | S Piscium. | 2519.8 | 10.7 | M. | | | | | | | | | |
| 011272 | S Cassiop. | 2501.8 | 9.6 | M, | 2520.6 | 9.4 | Pt, | 2550.8 | 10.5 | M, | 2554.6 | 10.7 | Pt. |
| 011712 | U Piscium. | 2519.8 | *11.2* | M. | | | | | | | | | |
| 012350 | RZ Persei | 2550.8 | 12.0 | M. | | | | | | | | | |
| 012502 | R Piscium | 2519.8 | 7.7 | M, | 2522.8 | 7.4 | Pt, | 2555.8 | 8.2 | Pt. | | | |
| 013238 | RU Androm. | 2519.8 | *12.1* | M, | 2550.8 | *12.1* | M. | | | | | | |
| 013338 | Y Androm. | 2519.8 | 11.2 | M, | 2550.8 | 10.0 | M. | | | | | | |
| 014958 | X Cassiop. | 2523.8 | 12.5 | M, | 2550.8 | *12.3* | M. | | | | | | |
| 015354 | U Persei | 2510.8 | 8.3 | M, | 2520.7 | 9.1 | Pt, | 2550.8 | 9.2 | M, | 2555.8 | 9.4 | Pt. |
| 021024 | R Arietis | 2518.8 | *10.0* | M, | 2527.8 | *10.8* | Ps, | 2530.6 | *11.9* | L, | 2556.7 | *10.0* | Ps. |
| 021143a | W Androm. | 2520.7 | 7.9 | Pt, | 2536.0 | 8.0 | Ml. | | | | | | |
| 021281 | Z Cephei | 2521.8 | *10.9* | M. | | | | | | | | | |
| *021403* | o Ceti | 2513.8 | 3.0 | M, | 2520.8 | 3.2 | Pt, | 2525.6 | 3.2 | L, | 2526.5 | 3.3 | Pe, |
| | | 2530.6 | 3.4 | L, | 2530.8 | 3.9 | $Ps_2$, | 2531.8 | 3.6 | My, | 2532.8 | 3.5 | M, |
| | | 2532.8 | 3.1 | Pt. | | | | | | | | | |
| 021558 | S Persei | 2532.8 | 11.2 | M. | | | | | | | | | |
| 022980 | RR Cephei | 2520.4 | *12.7* | L, | 2521.8 | *10.9* | M. | | | | | | |
| 023133 | R Trianguli | 2518.8 | 6.6 | M, | 2532.8 | 6.2 | M, | 2538.0 | 7.0 | Ml. | | | |
| 024356 | W Persei | 2518.8 | 10.0 | M, | 2520.8 | 9.9 | Pt, | 2527.8 | 10.0 | Ps, | 2532.8 | 9.5 | M, |
| | | 2532.8 | 10.0 | Ps, | 2546.7 | 10.1 | Pt, | 2556.7 | 10.2 | Ps. | | | |
| *031401* | X Ceti | 2530.6 | 9.7 | L. | | | | | | | | | |
| 032043 | Y Persei | 2520.8 | 8.5 | Pt, | 2554.8 | 8.8 | Pt. | | | | | | |
| 032335 | R Persei | 2520.8 | 9.5 | Pt, | 2532.8 | 9.8 | Pt. | | | | | | |
| 042215 | W Tauri | 2522.8 | 10.0 | M, | 2532.8 | 10.0 | M. | | | | | | |
| 043065 | T Camel. | 2523.4 | 8.8 | L, | 2554.8 | 9.4 | M. | | | | | | |
| 043274 | X Camel. | 2520.7 | 8.1 | Pt, | 2554.8 | 9.8 | M. | | | | | | |
| 050953 | R Aurigae | 2522.8 | 9.2 | Pt, | 2555.8 | 10.8 | Pt. | | | | | | |
| 053068 | S Camel. | 2520.6 | 10.0 | Pt, | 2555.8 | 10.5 | Pt. | | | | | | |
| 060450 | X Aurigae | 2450.4 | 9.6 | Ja. | | | | | | | | | |
| 060547 | SS Aurigae | 2450.4 | *13.0* | Ja, | 2457.1 | *11.5* | Ch, | 2522.8 | *12.4* | Pt, | 2525.6 | *12.4* | L, |
| | | 2530.6 | *11.6* | L, | 2532.8 | *12.6* | Pt. | | | | | | |
| 070122a | R Gemin. | 2453.1 | *11.0* | Ch. | | | | | | | | | |
| 072708 | S Can. Min. | 2459.1 | 10.1 | Ch. | | | | | | | | | |
| 074922 | U Gemin. | 2462.1 | *11.4* | Ch, | 2463.1 | *12.3* | Ch. | | | | | | |

VARIABLE STAR OBSERVATIONS, June 20 to August 20, 1920—Continued.

| Number | Name | J.D. | Est. | Obs. | J.D. | Est. | Obs. | J.D. | Est. | Obs. | J.D. | Est. | Obs. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 081112 | R Cancri | 2452.1 | 6.9 | Ch. | | | | | | | | | |
| 084803 | S Hydrae | 2452.1 | 10.3 | Ch, | 2484.1 | *11.0* | Ch. | | | | | | |
| *085008* | T Hydrae | 2462.1 | *11.0* | Ch. | | | | | | | | | |
| 090151 | V Urs. Maj. | 2482.4 | 10.7 | Pe, | 2493.7 | 10.1 | Mu. | | | | | | |
| 093934 | R Leo. Min. | 2469.8 | 9.1 | Ka, | 2481.8 | 9.8 | Ka. | | | | | | |
| 094211 | R Leonis | 2319.4 | 9.2 | Bp, | 2348.0 | 8.6 | $Bp_2$, | 2355.4 | 8.1 | $Bp_2$, | 2360.3 | 7.7 | Bp, |
| | | 2363.8 | 7.5 | $Bp_2$, | 2369.4 | 7.5 | $Bp_2$, | 2378.4 | 7.1 | $Bp_2$ | 2395.8 | 6.5 | $Bp_2$, |
| | | 2408.3 | 6.7 | Bp, | 2423.4 | 7.0 | $Bp_2$, | 2431.4 | 7.1 | $Bp_2$ | 2444.4 | 7.6 | Bp, |
| | | 2450.4 | 8.0 | $Bp_2$, | 2450.4 | 9.4 | Ja, | 2457.2 | 7.7 | Ch, | 2458.4 | 8.0 | $Bp_2$, |
| | | 2483.4 | 8.8 | Ja, | 2483.6 | 8.4 | Ps, | 2488.1 | 8.9 | Ch, | 2491.4 | 8.8 | $Bp_2$, |
| | | 2499.4 | 9.3 | Bp. | | | | | | | | | |
| 095421 | V Leonis | 2487.4 | 9.7 | Ja. | | | | | | | | | |
| 103769 | R Urs. Maj. | 2451.1 | 10.2 | Ch, | 2483.6 | 11.0 | Ps, | 2486.1 | *11.0* | Ch, | 2496.4 | *12.5* | Pe, |
| | | 2497.6 | 11.8 | Pi, | 2510.6 | *10.5* | Ps, | 2519.6 | 10.7 | Ps, | 2523.7 | 12.3 | M, |
| | | 2532.8 | *10.5* | Ps. | | | | | | | | | |
| 115919 | R Comae B. | 2450.4 | 11.5 | Ja, | 2457.4 | 10.8 | Ja, | 2480.9 | 8.8 | $Ja_2$, | 2487.4 | 8.7 | Ja, |
| | | 2498.4 | 9.1 | Ja, | 2503.6 | 8.7 | M, | 2510.4 | 9.5 | Ja, | 2519.7 | 9.4 | $Ja_2$. |
| 120012 | SU Virgin. | 2450.4 | 10.6 | Ja, | 2457.4 | 10.2 | Ja, | 2480.9 | 10.6 | $Ja_2$, | 2487.4 | 10.6 | Ja, |
| | | 2498.4 | 11.1 | Ja, | 2510.4 | 12.1 | Ja, | 2517.9 | 12.4 | $Ja_2$. | | | |
| 122001 | SS Virgin. | 2519.4 | 7.4 | L. | | | | | | | | | |
| 122532 | T Can. Ven. | 2503.6 | 9.8 | M, | 2510.6 | 9.9 | Ya, | 2515.7 | 10.4 | Pt, | 2525.6 | 10.5 | Pt, |
| | | 2531.6 | 10.4 | M, | 2552.7 | *11.0* | Bs. | | | | | | |
| 123160 | T Urs. Maj. | 2451.2 | *11.0* | Ch. | 2486.1 | *11.0* | Ch, | 2492.1 | 10.9 | Ch, | 2496.4 | 10.7 | Pe |
| | | 2497.6 | 10.6 | Pi, | 2497.6 | 10.6 | Wg, | 2497.6 | 10.9 | Bn, | 2501.6 | 10.1 | Po |
| | | 2514.6 | 8.7 | Pt, | 2516.6 | 8.9 | Cl, | 2516.6 | 8.6 | K, | 2517.6 | 8.6 | M, |
| | | 2523.6 | 8.5 | Ps, | 2523.6 | 8.6 | Cl, | 2523.7 | 8.5 | M, | 2525.6 | 8.5 | Pt, |
| | | 2531.6 | 8.4 | Po, | 2543.6 | *10.4* | Ps, | 2545.6 | 8.2 | M, | 2551.7 | 8.5 | B, |
| | | 2556.6 | 8.3 | Ps. | | | | | | | | | |
| 123307 | R Virgin. | 2433.9 | 10.8 | $Ka_2$, | 2445.8 | 8.3 | Ka, | 2455.9 | 8.0 | Ka, | 2482.7 | 7.2 | $Ka_2$, |
| | | 2484.4 | 7.1 | Pe, | 2487.3 | 7.0 | Pe, | 2510.6 | 7.9 | Ya, | 2514.6 | 8.4 | Pt, |
| | | 2514.6 | 8.6 | Ps, | 2519.4 | 9.0 | L, | 2522.6 | 9.5 | Ps, | 2525.6 | 9.0 | Pt. |
| 123459 | RS Urs. Maj. | 2451.2 | 10.2 | Ch, | 2486.1 | *11.0* | Ch, | 2496.4 | 12.9 | Pe, | 2497.6 | *11.8* | Pi, |
| | | 2516.6 | *12.0* | K. | 2516.6 | *12.0* | Cl, | 2523.7 | 14.0 | M, | 2551.7 | 10.7 | B, |
| 123961 | S Urs. Maj. | 2451.2 | 8.3 | Ch, | 2461.1 | 8.4 | $Ch_2$, | 2468.1 | 8.5 | $Ch_2$, | 2486.1 | 8.6 | Ch, |
| | | 2496.4 | 8.7 | Pe, | 2497.6 | 8.8 | Wg, | 2497.6 | 8.7 | Pi, | 2497.6 | 8.8 | Bn, |
| | | 2499.6 | 8.5 | O, | 2501.6 | 9.0 | Po, | 2503.6 | 8.8 | M, | 2510.1 | 8.9 | $O_2$, |
| | | 2514.6 | 9.3 | Pt, | 2516.6 | 9.2 | Cl, | 2516.6 | 9.4 | K, | 2519.6 | 9.4 | O, |
| | | 2522.4 | 10.0 | L, | 2523.6 | 9.1 | Cl, | 2523.6 | 10.5 | Ps, | 2523.7 | 9.5 | M, |
| | | 2525.6 | 10.2 | Pt, | 2528.4 | 10.0 | L, | 2531.6 | 10.2 | Po, | 2531.6 | 10.0 | M, |
| | | 2543.6 | *10.1* | Ps, | 2547.8 | *11.0* | Bs, | 2551.7 | 10.9 | B. | | | |
| 124204 | RU Virgin. | 2483.4 | 11.7 | Ja, | 2519.4 | 11.3 | Ja. | | | | | | |
| 124606 | U Virgin. | 2482.4 | 10.5 | Ja, | 2519.4 | *11.8* | Ja. | | | | | | |
| *132422* | R Hydrae | 2459.1 | 9.1 | Ch, | 2483.4 | 8.8 | L, | 2484.1 | 8.9 | Ch, | 2514.7 | 8.0 | Ml. |
| *132706* | S Virgin. | 2483.4 | 10.2 | Pe, | 2484.3 | 10.9 | Pe, | 2486.9 | 10.8 | $Pe_2$, | 2520.6 | 12.5 | Pt. |
| 133273 | T Urs. Min. | 2497.6 | *12.4* | Pi. | | | | | | | | | |
| 134440 | R Can. Ven. | 2500.8 | 7.8 | M, | 2501.7 | 7.8 | O, | 2509.7 | 7.7 | O, | 2510.6 | 7.4 | Ya, |
| | | 2512.6 | 7.7 | Po, | 2515.7 | 7.7 | Pt, | 2519.6 | 7.9 | O, | 2525.6 | 8.0 | Pt, |
| | | 2531.6 | 8.2 | M, | 2531.6 | 8.2 | Po, | 2541.6 | 8.3 | Ya. | | | |
| *135908* | RR Virgin. | 2482.4 | 11.3 | Ja. | | | | | | | | | |
| 140113 | Z Bootis | 2517.6 | 10.6 | M, | 2545.6 | 8.5 | M. | | | | | | |
| 141567 | U Urs. Min. | 2497.6 | 8.5 | Pi, | 2501.7 | 7.9 | Po, | 2501.8 | 8.4 | M, | 2502.7 | 7.6 | Ya, |
| | | 2515.7 | 8.3 | Pt, | 2531.7 | 8.5 | Po, | 2545.6 | 9.0 | M, | 2546.7 | 9.1 | Pt. |
| 141954 | S Bootis | 2501.6 | 10.2 | Po, | 2515.7 | 10.5 | Pt, | 2517.6 | 11.0 | M, | 2522.4 | 11.1 | L, |
| | | 2525.6 | 11.2 | Pt, | 2528.4 | 11.3 | L, | 2531.6 | 11.5 | M. | | | |
| 142205 | RS Virgin. | 2482.4 | 9.7 | Ja, | 2516.4 | 10.9 | Ja. | | | | | | |

VARIABLE STAR OBSERVATIONS, June 20 to August 20, 1920—Continued.

| Number | Name | J.D. | Est. | Obs. | J.D. | Est. | Obs. | J.D. | Est. | Obs. | J.D. | Est. | Obs. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 142539 | V Bootis | 2469.9 | 10.2 | Ka, | 2484.9 | 10.3 | Ka, | 2495.6 | 10.7 | Wg, | 2501.6 | 10.6 | Pi |
| | | 2503.7 | 10.3 | M, | 2514.6 | 11.1 | Ps, | 2515.7 | 10.8 | Pt, | 2517.6 | 10.8 | M, |
| | | 2519.6 | 11.0 | Ps, | 2521.6 | 10.8 | Po, | 2522.4 | 11.1 | L, | 2523.6 | 11.0 | K, |
| | | 2525.7 | 10.9 | Pt, | 2526.6 | 10.8 | Wg, | 2528.4 | 10.9 | L, | 2532.6 | 10.7 | Po. |
| | | 2545.6 | 10.1 | M, | 2553.7 | 9.6 | E, | 2554.6 | 9.4 | Su, | 2556.6 | 9.0 | Ps. |
| 142584 | R Camel. | 2497.6 | *12.2* | Pi, | 2531.6 | *12.2* | M. | | | | | | |
| 143227 | R Bootis | 2501.7 | *10.2* | Po, | 2517.6 | 10.5 | M, | 2545.6 | 9.8 | M, | 2545.6 | 9.6 | Su. |
| 144918 | U Bootis | 2517.6 | 10.4 | M, | 2518.7 | 10.5 | Pt, | 2528.4 | 10.5 | Gi, | 2531.6 | 10.2 | M, |
| | | 2535.4 | 9.9 | Gi, | 2551.7 | 10.7 | B. | | | | | | |
| *150605* | Y Librae | 2534.9 | 8.4 | Ml. | | | | | | | | | |
| *151520* | S Librae | 2459.6 | 10.0 | $Ch_2$, | 2484.2 | *10.4* | Ch, | 2520.4 | 12.0 | L. | | | |
| 151714 | S Serpentis | 2487.4 | 12.3 | Ja, | 2510.7 | 11.0 | O, | 2517.4 | 10.3 | Ja, | 2517.6 | 10.0 | M, |
| | | 2523.4 | 8.9 | Ja, | 2524.4 | 8.4 | L, | 2526.5 | 8.7 | Ja, | 2532.6 | 7.6 | M, |
| | | 2534.9 | 7.9 | Ml. | | | | | | | | | |
| 151731 | S Cor. Bor. | 2454.1 | 10.5 | Ch, | 2484.2 | 10.7 | Ch, | 2497.6 | 11.4 | Ya, | 2500.8 | 12.0 | Pt, |
| | | 2510.8 | *11.8* | M, | 2525.7 | 12.4 | Pt, | 2550.6 | 13.1 | B. | | | |
| *151822* | RS Librae | 2511.7 | 8.0 | Ml, | 2520.4 | 8.0 | L. | | | | | | |
| *152714* | RU Librae | 2520.7 | 11.2 | Pt. | | | | | | | | | |
| 153378 | S Urs. Min. | 2483.3 | 10.7 | $Ka_2$, | 2497.6 | 10.3 | Pi, | 2511.6 | 10.0 | Wg, | 2511.6 | 9.8 | Bn, |
| | | 2516.6 | 9.8 | Cl, | 2516.6 | 9.9 | K, | 2519.6 | 9.5 | M, | 2520.8 | 9.5 | Pt, |
| | | 2521.7 | 9.7 | Po, | 2523.6 | 8.5 | My, | 2526.6 | 9.9 | Wg, | 2532.6 | 9.6 | Po, |
| | | 2546.7 | 9.2 | Pt, | 2548.7 | 9.6 | Bs, | 2554.6 | 8.4 | Su. | | | |
| 154428 | R Cor. Bor. | 2432.9 | 6.4 | Ka, | 2459.1 | 6.4 | Ch, | 2469.8 | 6.8 | Ka, | 2483.3 | 6.1 | Pe, |
| | | 2483.4 | 6.5 | L, | 2483.4 | 6.8 | Ja, | 2483.6 | 6.1 | Ps, | 2484.2 | 6.4 | Ch, |
| | | 2484.9 | 6.6 | Ka, | 2485.7 | 6.4 | Ka, | 2487.4 | 6.5 | Pe, | 2491.7 | 6.3 | Mu, |
| | | 2493.7 | 6.5 | Mu, | 2495.7 | 6.6 | Mu, | 2497.6 | 6.5 | Wg, | 2497.6 | 6.5 | Ya, |
| | | 2497.6 | 6.4 | Bn, | 2497.7 | 6.4 | Mu, | 2498.4 | 6.2 | Pe, | 2499.6 | 6.6 | K, |
| | | 2499.8 | 6.2 | Pt, | 2499.7 | 6.4 | O, | 2500.6 | 6.8 | Th, | 2500.6 | 6.6 | K, |
| | | 2500.8 | 6.4 | M, | 2500.8 | 6.3 | Pt, | 2501.6 | 6.4 | Pi, | 2501.6 | 6.5 | O, |
| | | 2501.8 | 6.4 | M, | 2502.6 | 6.5 | O, | 2505.7 | 6.2 | Bh, | 2506.7 | 6.1 | Bh, |
| | | 2509.6 | 6.5 | O, | 2509.8 | 6.4 | M, | 2510.6 | 6.4 | Bn, | 2510.6 | 5.9 | Ps, |
| | | 2510.7 | 6.6 | O, | 2511.6 | 6.6 | Wg, | 2511.7 | 6.6 | Bh, | 2512.4 | 6.4 | L, |
| | | 2512.6 | 6.2 | Bh, | 2512.7 | 6.3 | Mu, | 2513.3 | 6.7 | Pe, | 2513.6 | 6.3 | Pt, |
| | | 2513.7 | 6.9 | Mu, | 2514.6 | 6.0 | Ps, | 2514.6 | 6.2 | Pt, | 2514.6 | 6.5 | O, |
| | | 2514.6 | 6.5 | Bn, | 2515.6 | 6.3 | Pt, | 2515.7 | 6.6 | Su, | 2516.4 | 6.5 | Gi, |
| | | 2516.6 | 6.8 | Cl, | 2516.6 | 6.5 | K, | 2516.7 | 6.8 | Mu, | 2518.6 | 6.1 | Pt, |
| | | 2518.7 | 6.7 | Mu, | 2519.4 | 6.6 | Gi, | 2519.4 | 6.3 | L, | 2519.6 | 6.5 | Cl, |
| | | 2519.6 | 6.5 | O, | 2519.6 | 6.1 | My, | 2519.6 | 6.7 | Su, | 2519.6 | 6.5 | K, |
| | | 2519.7 | 5.9 | Ps, | 2520.6 | 6.2 | Pt, | 2520.8 | 6.4 | Mu, | 2522.3 | 6.3 | Pe, |
| | | 2522.4 | 6.2 | L, | 2522.6 | 6.2 | Pt, | 2522.6 | 5.8 | My, | 2522.6 | 6.2 | Ps, |
| | | 2522.7 | 6.7 | Mu, | 2522.8 | 6.5 | Su, | 2522.8 | 6.2 | M, | 2523.4 | 6.5 | Gi, |
| | | 2523.4 | 6.4 | L, | 2523.6 | 5.8 | My, | 2523. 6 | 6.8 | K, | 2523.6 | 6.5 | Ps, |
| | | 2523.6 | 7.0 | Cl, | 2524.6 | 6.1 | Pt, | 2524.7 | 6.8 | Mu, | 2525.5 | 6.3 | L, |
| | | 2525.6 | 6.3 | Pt, | 2525.7 | 6.7 | Mu, | 2526.6 | 6.7 | Wg, | 2526.6 | 6.9 | Cl, |
| | | 2527.4 | 6.5 | L, | 2527.6 | 6.9 | Cl, | 2527.7 | 6.7 | Ps, | 2531.4 | 6.5 | Gi, |
| | | 2531.5 | 6.4 | Cl, | 2531.6 | 5.7 | My, | 2531.6 | 6.2 | M, | 2531.7 | 6.7 | Ri, |
| | | 2532.6 | 6.4 | Cl, | 2532.8 | 6.8 | Ps, | 2533.5 | 6.8 | Th, | 2533.6 | 6.8 | Cl, |
| | | 2533.6 | 6.8 | Ps, | 2540.6 | 6.7 | Su, | 2540.7 | 6.2 | Mu, | 2541.6 | 6.7 | Ro. |
| | | 2541.7 | 6.5 | Mu, | 2542.6 | 6.4 | Cl, | 2542.6 | 6.1 | Pt, | 2543.6 | 6.5 | Cl, |
| | | 2543.7 | 6.7 | Mu. | 2545.6 | 6.7 | Cl, | 2545.6 | 6.4 | Su, | 2545.7 | 6.4 | Mu, |
| | | 2546.6 | 6.1 | Pt. | 2547.6 | 6.2 | Pt, | 2547.7 | 6.7 | Mu, | 2548.7 | 6.5 | Su, |
| | | 2548.7 | 7.0 | Bs, | 2549.7 | 6.7 | Mu, | 2549.8 | 7.3 | Bs, | 2550.6 | 6.5 | B, |
| | | 2553.6 | 6.2 | Ps, | 2553.6 | 6.5 | Su, | 2553.7 | 6.0 | E, | 2554 6 | 6.0 | Pt, |
| | | 2556.6 | 6.3 | Ps. | | | | | | | | | |
| 154536 | X Cor. Bor. | 2501.8 | 10.2 | M, | 2531.6 | 10.0 | M, | 2551.7 | 12.7 | B. | | | |

VARIABLE STAR OBSERVATIONS, June 20 to August 20, 1920—Continued.

| Number | Name | J.D. | Est. | Obs. | J.D. | Est. | Obs. | J.D. | Est. | Obs. | J.D. | Est. | Obs. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 154615 | R Serpentis | 2457.5 | 8.3 | Ja, | 2478.4 | 9.1 | Ja, | 2492.1 | 7.2 | Ch, | 2499.6 | 9.7 | O, |
| | | 2509.7 | 10.5 | O, | 2510.4 | 11.1 | Ja, | 2511.7 | 10.8 | Ml, | 2514.6 | 10.5 | Pt, |
| | | 2517.6 | 10.5 | M, | 2519.4 | 11.6 | Ja, | 2525.7 | 11.2 | Pt, | 2531.6 | 11.3 | M, |
| | | 2534.9 | 11.6 | Ml, | 2553.7 | *11.3* | E. | | | | | | |
| 154639 | V Cor. Bor. | 2501.8 | 10.8 | M, | 2518.7 | 11.3 | Pt, | 2525.7 | 11.5 | Pt, | 2531.6 | 10.7 | M, |
| | | 2553.7 | 10.1 | E. | | | | | | | | | |
| *154715* | R Librae | 2523.7 | 11.2 | M. | | | | | | | | | |
| *155018* | RR Librae | 2519.4 | 12.6 | L. | | | | | | | | | |
| 160118 | R Herculis | 2482.4 | *13.2* | Ja, | 2518.4 | 9.4 | $Ja_2$, | 2523.4 | 9.4 | Ja, | 2535.4 | 9.5 | Ja. |
| 160150 | RR Herculis | 2534.9 | 8.5 | Ml. | | | | | | | | | |
| 160210 | U Serpentis | 2523.7 | 11.2 | M, | 2531.6 | 10.7 | M, | 2546.7 | 10.1 | Pt. | | | |
| 160625 | RU Herculis | 2509.7 | 8.7 | O, | 2510.8 | 8.9 | M, | 2511.7 | 8.8 | Ml, | 2514.7 | 8.8 | Po, |
| | | 2518.7 | 8.2 | Pt, | 2520.4 | 8.8 | $Ja_2$, | 2523.7 | 9.0 | Po, | 2531.6 | 8.3 | M, |
| | | 2546.7 | 9.2 | Pt. | | | | | | | | | |
| *161122a* | R Scorpii | 2487.4 | *12.2* | Pe, | 2518.7 | 10.7 | Pt, | 2519.4 | 10.8 | $Ja_2$, | 2525.8 | 9.8 | Mz, |
| | | 2530.5 | 10.4 | $Ja_2$, | 2546.6 | 9.3 | Pt. | | | | | | |
| *161122b* | S Scorpii | 2457.5 | 11.0 | Ja, | 2482.4 | 12.1 | Ja, | 2487.4 | *12.2* | Pe, | 2523.7 | *14.0* | M. |
| *161122c* | T Scorpii | 2523.7 | 13.5 | M, | 2525.8 | 12.2 | Mz. | | | | | | |
| 161138 | W Cor. Bor. | 2501.6 | 9.0 | Pi, | 2501.7 | 8.9 | Po, | 2503.7 | 8.5 | M, | 2531.6 | 9.0 | M, |
| | | 2534.9 | 9.5 | Ml, | 2550.7 | 10.2 | B. | | | | | | |
| *161607* | W Ophiuchi | 2520.4 | 11.3 | L. | | | | | | | | | |
| *162112* | V Ophiuchi | 2487.5 | 8.9 | Ja, | 2519.5 | 9.9 | Ja. | | | | | | |
| 162119 | U Herculis | 2456.2 | *11.0* | Ch, | 2523.7 | 13.0 | M, | 2533.6 | *10.4* | Ps. | | | |
| *162319* | Y Scorpii | 2518.4 | *13.5* | Gi. | | | | | | | | | |
| 162807 | SS Herculis | 2522.7 | 11.5 | M, | 2531.6 | 10.6 | Cl, | 2531.6 | 10.2 | M. | | | |
| 163137 | W Herculis | 2517.4 | 12.9 | Ja, | 2523.4 | 13.0 | Ja, | 2523.7 | 13.0 | M. | | | |
| 163172 | R Urs. Min. | 2503.6 | 9.5 | M, | 2531.6 | 10.0 | M. | | | | | | |
| 163266 | R Draconis | 2460.2 | 7.7 | Ch, | 2470.2 | 8.0 | Ch, | 2482.1 | 9.4 | Ch, | 2497.6 | 10.4 | Pi, |
| | | 2501.7 | 10.0 | O, | 2503.6 | 10.4 | M, | 2520.7 | 11.3 | Pt, | 2523.7 | *11.0* | Po, |
| | | 2531.6 | 11.8 | M. | | | | | | | | | |
| 164055 | S Draconis | 2515.8 | 9.0 | M, | 2532.8 | 10.0 | M. | | | | | | |
| 164715 | S Herculis | 2520.4 | 8.9 | Gi, | 2520.7 | 9.4 | Pt, | 2522.8 | 9.5 | M, | 2525.7 | 9.5 | Pt, |
| | | 2530.5 | 9.3 | Gi, | 2531.6 | 9.5 | M, | 2532.6 | 9.3 | Cl, | 2542.6 | 10.1 | Cl. |
| *165030* | RR Scorpii | 2534.9 | 6.8 | Ml. | | | | | | | | | |
| 165631 | RV Herculis | 2517.4 | 13.6 | Ja, | 2520.7 | 13.3 | Pt, | 2423.4 | 12.5 | Ja, | 2523.7 | 13.1 | M, |
| | | 2526.5 | 12.5 | Ja, | 2526.6 | 12.0 | Cl, | 2531.6 | *12.2* | Cl, | 2545.6 | 10.5 | M, |
| | | 2546.7 | 10.9 | Pt, | 2553.7 | 10.1 | E. | | | | | | |
| *170215* | R Ophiuchi | 2460.2 | 8.6 | Ch, | 2470.2 | 8.4 | Ch, | 2478.7 | 8.4 | $Ch_2$, | 2487.4 | 8.9 | Pe, |
| | | 2493.7 | 9.0 | Mu, | 2494.2 | 8.6 | Ch, | 2510.8 | 9.3 | M, | 2514.6 | 9.4 | Pt, |
| | | 2514.7 | 9.2 | Ps, | 2519.7 | 9.2 | Ps, | 2544.3 | 10.6 | $Bs_2$, | 2546.7 | 10.6 | Bs. |
| 170627 | RT Herculis | 2502.8 | 9.7 | M, | 2520.7 | 10.8 | Pt, | 2545.6 | 11.8 | M, | 2546.7 | 12.4 | Pt. |
| 171401 | Z Ophiuchi | 2500.8 | 10.7 | Pt, | 2510.7 | 11.0 | O, | 2517.4 | 11.0 | Ja, | 2522.5 | 11.1 | Gi, |
| | | 2532.6 | 11.6 | Cl, | 2534.4 | 11.4 | Gi, | 2542.6 | 11.9 | Cl, | 2547.6 | 11.9 | Pt, |
| 171723 | RS Herculis | 2482.4 | 9.1 | Ja, | 2502.8 | 8.5 | M, | 2517.4 | 8.4 | Ja, | 2518.6 | 7.9 | Pt, |
| | | 2523.4 | 8.0 | Ja, | 2526.5 | 8.0 | Ja, | 2534.9 | 8.0 | Ml, | 2535.4 | 7.7 | Ja, |
| | | 2540.8 | 7.9 | M, | 2546.7 | 8.6 | Pt. | | | | | | |
| 172809 | RU Ophiuchi | 2500.8 | 12.5 | Pt, | 2519.4 | 13.0 | Ja, | 2523.7 | 14.3 | M, | 2553.7 | *12.3* | E. |
| 173557 | TY Draconis | 2487.4 | 8.7 | Pe. | | | | | | | | | |
| 175458a | T Draconis | 2522.4 | 10.1 | Gi, | 2523.8 | 10.5 | M, | 2531.5 | 10.3 | Gi. | | | |
| 175458b | UY Draconis | 2523.8 | 11.7 | M. | | | | | | | | | |
| 175519 | RY Herculis | 2461.2 | 10.2 | Ch, | 2483.4 | 12.3 | Pe. | | | | | | |

VARIABLE STAR OBSERVATIONS, June 20 to August 20, 1920—Continued.

| Number | Name | J.D. | Est. | Obs. | J.D. | Est. | Obs. | J.D. | Est. | Obs. | J.D. | Est. | Obs. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 180531 | T Herculis | 2460.2 | 11.2 | Ch, | 2483.4 | 10.5 | Pe, | 2484.2 | 10.8 | Ch, | 2486.3 | 9.7 | Pe, |
| | | 2492.1 | 9.6 | Ch, | 2500.4 | 9.1 | Pe, | 2500.8 | 9.0 | Pt, | 2501.8 | 8.6 | M, |
| | | 2514.7 | 7.8 | Ps, | 2517.5 | 7.9 | L, | 2519.7 | 7.9 | O, | 2519.7 | 7.5 | Ps, |
| | | 2522.7 | 7.8 | Ps, | 2522.8 | 7.9 | Su, | 2523.4 | 7.7 | Ja, | 2523.6 | 7.4 | Po, |
| | | 2530.6 | 7.5 | L, | 2531.6 | 7.2 | My, | 2532.8 | 7.4 | Ps, | 2540.8 | 7.8 | M, |
| | | 2545.7 | 7.8 | Su, | 2546.7 | 7.8 | Pt, | 2556.6 | 8.4 | Ps. | | | |
| 180565 | W Draconis | 2518.8 | *11.6* | M. | | | | | | | | | |
| 180666 | X Draconis | 2518.8 | 10.9 | M. | | | | | | | | | |
| 180911 | Nova Ophiu.4 | 2500.3 | 10.8 | $Pt_2$, | 2514.6 | 10.6 | Pt, | 2517.5 | 10.1 | L, | 2519.0 | 11.3 | $Gi_2$, |
| | | 2520.4 | 10.7 | $Pt_3$, | 2525.6 | 10.7 | Pt, | 2529.9 | 11.4 | $Gi_2$, | 2541.6 | 10.8 | $Pt_2$, |
| | | 2549.6 | 10.8 | $Pt_2$, | 2551.6 | 10.7 | B. | | | | | | |
| 181103 | RY Ophiuchi | 2502.8 | 8.5 | M, | 2520.5 | 10.4 | Gi, | 2530.5 | 11.3 | Gi, | 2536.4 | 11.4 | Gi, |
| | | 2545.6 | *12.0* | M. | | | | | | | | | |
| 181136 | W Lyrae | 2483.4 | 8.0 | Ja, | 2493.7 | 9.1 | Mu, | 2500.4 | 8.8 | Pe, | 2501.6 | 9.0 | Pi, |
| | | 2502.8 | 8.8 | M, | 2514.8 | 9.2 | M, | 2517.5 | 9.5 | L, | 2518.6 | 9.6 | Pt, |
| | | 2519.4 | 9.6 | Ja, | 2522.6 | 9.7 | Ps, | 2523.6 | 9.8 | Su, | 2532.8 | 10.4 | Ps, |
| | | 2540.8 | 10.3 | M, | 2556.6 | *11.7* | Ps. | | | | | | |
| 182224 | SV Herculis | 2523.4 | 11.9 | L. | | | | | | | | | |
| 182306 | T Serpentis | 2487.4 | 12.6 | Ja, | 2519.4 | 12.8 | Ja. | | | | | | |
| 183225 | RZ Herculis | 2514.8 | *11.6* | M. | | | | | | | | | |
| 183308 | X Ophiuchi | 2501.8 | 6.8 | M, | 2512.6 | 7.2 | $O_2$, | 2517.5 | 7.2 | L, | 2519.5 | 7.7 | Ja, |
| | | 2519.7 | 7.4 | O, | 2531.6 | 7.6 | Cl, | 2534.9 | 7.6 | Ml, | 2540.8 | 7.4 | M, |
| | | 2540.6 | 8.0 | Cl, | 2551.6 | 8.0 | B. | | | | | | |
| *184205* | R Scuti | 2457.5 | 5.8 | Ja, | 2461.2 | 5.2 | Ch, | 2469.9 | 5.4 | Ka, | 2482.2 | 5.0 | Ch, |
| | | 2482.4 | 5.3 | Ja, | 2482.4 | 5.0 | Pe, | 2483.4 | 5.2 | Ja, | 2483.4 | 5.0 | L, |
| | | 2484.4 | 5.2 | Pe, | 2486.4 | 5.2 | Pe, | 2491.7 | 5.8 | Mu, | 2493.7 | 5.6 | Mu, |
| | | 2494.4 | 5.6 | Pe, | 2495.7 | 5.7 | Mu, | 2496.5 | 5.6 | Ja, | 2497.7 | 5.6 | Ya, |
| | | 2497.7 | 5.8 | Mu, | 2499.4 | 5.8 | Ja, | 2499.8 | 6.8 | Pt, | 2500.8 | 5.9 | Pt, |
| | | 2501.4 | 6.0 | Ja, | 2501.8 | 5.4 | M, | 2504.4 | 6.3 | Ja, | 2505.7 | 6.1 | Bh, |
| | | 2506.7 | 6.0 | Bh, | 2510.3 | 5.8 | Pe, | 2510.4 | 6.6 | Ja, | 2510.6 | 6.1 | Su, |
| | | 2511.6 | 6.7 | Ps, | 2511.6 | 6.1 | O, | 2511.7 | 7.1 | Bh, | 2512.6 | 7.1 | Bh, |
| | | 2512.6 | 6.1 | Bn, | 2512.7 | 6.8 | Mu, | 2513.3 | 5.9 | Pe, | 2513.7 | 7.0 | Mu, |
| | | 2514.6 | 6.4 | Pt, | 2514.6 | 6.0 | O, | 2514.8 | 6.6 | M, | 2515.6 | 6.5 | Pt, |
| | | 2515.7 | 6.3 | Su, | 2515.8 | 6.8 | M, | 2516.4 | 6.8 | Gi, | 2516.4 | 6.6 | Ja, |
| | | 2516.7 | 7.2 | Mu, | 2516.8 | 6.9 | M, | 2518.6 | 6.7 | Su, | 2518.6 | 6.5 | Pt, |
| | | 2518.7 | 7.4 | Mu, | 2519.4 | 6.8 | Gi, | 2519.4 | 6.7 | L, | 2519.5 | 7.0 | Ja, |
| | | 2519.6 | 6.3 | My, | 2519.6 | 6.0 | O, | 2519.7 | 6.5 | Ps, | 2520.7 | 6.4 | Pt, |
| | | 2520.8 | 7.3 | Mu, | 2521.8 | 7.0 | M, | 2522.3 | 5.9 | Pe, | 2522.4 | 6.8 | Ja, |
| | | 2522.6 | 6.6 | Ps, | 2522.6 | 6.7 | Su, | 2522.6 | 6.3 | Pt, | 2522.6 | 6.2 | My, |
| | | 2522.7 | 7.3 | Mu, | 2522.8 | 7.0 | M, | 2523.4 | 6.9 | Gi, | 2523.6 | 6.3 | Ps, |
| | | 2523.6 | 6.2 | My, | 2524.6 | 6.5 | Pt, | 2524.7 | 6.9 | Mu, | 2525.6 | 6.3 | Pt, |
| | | 2525.7 | 6.8 | Mu, | 2526.5 | 6.7 | Ja, | 2527.7 | 6.1 | Ps, | 2530.5 | 6.4 | Ja, |
| | | 2530.5 | 6.4 | Gi, | 2530.6 | 6.1 | L, | 2531.6 | 6.2 | My, | 2532.8 | 6.0 | M, |
| | | 2532.8 | 5.8 | Ps, | 2533.8 | 5.7 | Ps, | 2534.4 | 6.1 | Ja, | 2535.4 | 6.1 | L, |
| | | 2539.6 | 6.0 | Pt, | 2540.6 | 6.1 | Su, | 2540.7 | 6.0 | Mu, | 2540.8 | 5.9 | M, |
| | | 2541.7 | 5.9 | Mu, | 2542.6 | 6.3 | Pt, | 2543.6 | 5.0 | Ps, | 2543.6 | 6.0 | Pt, |
| | | 2543.7 | 5.9 | Mu, | 2545.7 | 5.3 | Su, | 2545.7 | 5.9 | Mu, | 2546.6 | 5.9 | Pt, |
| | | 2546.7 | 6.1 | Bs, | 2547.6 | 5.8 | Pt, | 2547.7 | 5.8 | Mu, | 2549.7 | 5.8 | Mu, |
| | | 2550.8 | 5.2 | M, | 2554.6 | 5.6 | Pt. | 2554.6 | 5.6 | Su, | 2555.6 | 5.5 | Pt, |
| | | 2556.6 | 5.2 | Ps. | | | | | | | | | |
| 184243 | RW Lyrae | 2501.6 | *12.3* | Pi. | | | | | | | | | |
| 184300 | Nova Aquil.3 | 2457.5 | 8.4 | Ja, | 2460.2 | 8.3 | Ch, | 2482.4 | 8.5 | Ja. | 2483.9 | 8.2 | $Pe_2$, |
| | | 2485.2 | 8.6 | Ch . | 2487.4 | 8.4 | Pe, | 2497.7 | 8.4 | Ya, | 2498.4 | 8.4 | $Pe_2$, |
| | | 2499.6 | 8.3 | K, | 2500.3 | 8.7 | $Pt_2$, | 2500.6 | 8.2 | Th, | 2500.6 | 8.2 | K, |
| | | 2501.4 | 8.4 | Ja, | 2501.8 | 8.4 | M, | 2514.6 | 8.8 | Pt, | 2515.8 | 8.4 | M, |
| | | 2516.4 | 8.7 | Ja, | 2516.6 | 8.4 | K, | 2516.6 | 8.5 | Cl. | 2519.5 | 9.2 | $Gi_3$, |
| | | 2520.4 | 8.6 | $Pt_3$, | 2522.8 | 8.5 | M, | 2523.6 | 8.5 | Cl, | 2524.4 | 8.4 | L, |
| | | 2526.5 | 8.5 | Ja, | 2529.1 | 8.7 | $Pt_2$, | 2530.5 | 9.0 | Gi, | 2532.6 | 8.5 | $Cl_3$, |
| | | 2532.8 | 8.7 | M, | 2533.5 | 8.3 | Th, | 2536.4 | 9.1 | Gi, | 2541.6 | 8.7 | Ro, |
| | | 2541.9 | 8.5 | $Pt_3$, | 2542.3 | 8.5 | $Cl_3$, | 2549.6 | 8.6 | $Pt_3$, | 2550.8 | 8.2 | M, |
| | | 2560.6 | 8.9 | Ro. | | | | | | | | | |

VARIABLE STAR OBSERVATIONS, June 20 to August 20, 1920—Continued.

| Number | Name | J.D. | Est. | Obs. | J.D. | Est. | Obs. | J.D. | Est. | Obs. | J.D. | Est. | Obs. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 184929 | Nova Lyrae | 2515.4 | 11.9 | Gi. | 2523.4 | 12.0 | Gi, | 2532.4 | 12.4 | Gi. | | | |
| 185032 | RX Lyrae | 2483.4 | 12.8 | Ja, | 2523.8 | 15.0 | M. | | | | | | |
| 185243 | R Lyrae | 2591.7 | 4.1 | Mu. | 2493.7 | 4.2 | Mu, | 2497.7 | 4.2 | Mu, | 2505.7 | 4.4 | Bh, |
| | | 2506.7 | 4.3 | Bh, | 2511.7 | 4.3 | Bh, | 2512 6 | 4.2 | Bh, | 2512.7 | 4.2 | Mu. |
| *185905* | V Aquilae | 2483.4 | 7.6 | $Pe_2$. | | | | | | | | | |
| 190108 | R Aquilae | 2518.7 | 11.4 | Pt, | 2519.8 | 10.9 | M, | 2547.6 | 10.2 | Pt. | | | |
| 190529 | V Lyrae | 2522.8 | 12.5 | M. | | | | | | | | | |
| 190926 | X Lyrae | 2503.7 | 9.0 | M, | 2510.7 | 9.2 | O, | 2532.8 | 9.0 | M. | | | |
| 190967 | U Draconis | 2519.8 | 12.3 | M, | 2532.8 | 12.5 | M. | | | | | | |
| *191019* | R Sagittarii | 2520.7 | 11.0 | Pt, | 2525.7 | 11.0 | Pt. | | | | | | |
| *191033* | RY Sagittarii | 2499.8 | 6.2 | Pt, | 2500.8 | 6.1 | Pt, | 2514.7 | 6.4 | Pt, | 2517.5 | 6.7 | L, |
| | | 2518.7 | 6.5 | Pt, | 2520.7 | 6.3 | Pt, | 2522.8 | 6.4 | Pt, | 2525.7 | 6.5 | Pt, |
| | | 2527.6 | 5.9 | L, | 2546.6 | 6.3 | Pt, | 2554.6 | 6.6 | Pt, | 2555.6 | 6.5 | Pt. |
| *191319* | S Sagittarii | 2518.4 | 13.1 | Gi, | 2525.5 | 13.5 | Gi. | | | | | | |
| *191321* | Z Sagittarii | 2518.4 | 11.8 | Gi, | 2525.5 | 11.1 | Gi, | 2536.4 | 10.4 | Gi. | | | |
| 191637 | U Lyrae | 2501.6 | 10.2 | Pi, | 2514.6 | 10.3 | Pt, | 2514.7 | 10.1 | O, | 2514.8 | 10.1 | M, |
| | | 2532.8 | 10.2 | M, | 2554.8 | 10.1 | Pt. | | | | | | |
| 191717 | T Sagittarii | 2536.0 | 9.3 | Ml. | | | | | | | | | |
| 192928 | TY Cygni | 2523.8 | 13.4 | M. | | | | | | | | | |
| 193311 | RT Aquilae | 2526.6 | 12.0 | Cl. | | | | | | | | | |
| 193449 | R Cygni | 2463.2 | 11.2 | Ch, | 2480.4 | 12.4 | Pe, | 2482.2 | 11.4 | Ch, | 2484.4 | 12.2 | Pe, |
| | | 2495.1 | 11.8 | Ch, | 2501.6 | 11.8 | Pi, | 2503.8 | 12.3 | M, | 2523.8 | 12.6 | M, |
| | | 2527.9 | 12.0 | Ri, | 2532.8 | 12.8 | M. | | | | | | |
| 193509 | RV Aquilae | 2501.7 | 8.8 | O, | 2511.6 | 8.5 | O, | 2518.7 | 9.0 | Pt, | 2519.7 | 8.6 | O, |
| | | 2522.8 | 9.6 | M, | 2542.7 | 13.1 | Mz, | 2547.6 | 9.7 | Pt. | | | |
| 193732 | TT Cygni | 2526.7 | 9.2 | Cl, | 2532.8 | 8.9 | M. | | | | | | |
| 194048 | RT Cygni | 2463.2 | 10.9 | Ch, | 2482.2 | 8.4 | Ch, | 2487.3 | 8.4 | Pe, | 2495.1 | 7.8 | Ch, |
| | | 2499.8 | 8.2 | $Pe_3$, | 2501.6 | 7.8 | O, | 2501.6 | 8.0 | Pi, | 2501.7 | 8.0 | Ya, |
| | | 2503.6 | 7.0 | M, | 2512.1 | 7.9 | $O_3$, | 2514.7 | 7.3 | Pt, | 2519.7 | 7.5 | O, |
| | | 2520.4 | 7.8 | Gi, | 2523.6 | 7.9 | Po, | 2530.4 | 7.8 | Gi, | 2531.6 | 7.5 | My, |
| | | 2532.8 | 7.9 | M, | 2554.8 | 7.8 | Pt, | 2557.5 | 8.4 | Po. | | | |
| 194348 | TU Cygni | 2503.6 | *12.4* | M, | 2532.8 | 11.7 | M. | | | | | | |
| 194604 | X Aquilae | 2498.6 | *12.0* | Cl, | 2500.8 | *12.0* | M, | 2542.7 | 13.2 | Mz. | | | |
| 194632 | $\chi$ Cygni | 2461.2 | 9.0 | Ch, | 2479.4 | 7.3 | Ja, | 2483.4 | 7.1 | Ja, | 2483.9 | 6.8 | $Pe_2$, |
| | | 2485.2 | 7.0 | Ch, | 2487.4 | 6.5 | Ja, | 2489.4 | 6.0 | $Pe_3$, | 2495.2 | 5.8 | Ch, |
| | | 2500.4 | 5.3 | $Ja_3$, | 2500.5 | 5.4 | $Pe_3$, | 2500.8 | 5.3 | Pt, | 2501.9 | 5.2 | $O_4$, |
| | | 2502.6 | 5.4 | Ya, | 2503.6 | 5.7 | M, | 2510.4 | 5.4 | Ja, | 2511.0 | 5.2 | $O_5$, |
| | | 2512.8 | 5.3 | $Pe_2$, | 2519.3 | 5.3 | $Pe_2$, | 2519.4 | 5.6 | $Ja_2$, | 2519.6 | 5.2 | O, |
| | | 2520.7 | 5.5 | Pt, | 2523.6 | 5.4 | Po, | 2530.5 | 6.1 | $Ja_2$, | 2532.8 | 5.8 | M, |
| | | 2532.8 | 5.9 | Pt, | 2550.6 | 6.0 | B, | 2557.6 | 6.8 | Po. | | | |
| 195116 | S Sagittæ | 2491.7 | 6.0 | Mu, | 2493.7 | 5.7 | Mu, | 2495.7 | 5.3 | Mu, | | | |
| | | 2497.7 | 5.6 | Mu, | 2510.6 | 5.5 | Bn, | 2511.6 | 5.5 | Wg, | | | |
| | | 2512.7 | 5.7 | Mu, | 2513.7 | 5.5 | Mu, | 2516.7 | 6.1 | Mu, | | | |
| | | 2518.7 | 5.3 | Mu, | 2520.8 | 5.4 | Mu, | 2522.7 | 5.9 | Mu, | | | |
| | | 2524.7 | 6.3 | Mu, | 2525.7 | 6.1 | Mu, | 2540.7 | 5.6 | Mu, | | | |
| | | 2541.7 | 5.8 | Mu, | 2543.7 | 6.0 | Mu, | 2545.7 | 5.3 | Mu, | | | |
| | | 2547.7 | 5.4 | Mu. | 2549.7 | 6.0 | Mu. | | | | | | |
| 195849 | Z Cygni | 2481.9 | 9.8 | $Pe_2$, | 2493.7 | 10.7 | Mu, | 2496.4 | 10.2 | Pe, | 2501.6 | 11.6 | Pi, |
| | | 2501.7 | 11.3 | Ya, | 2503.6 | 11.4 | M, | 2514.7 | 11.6 | Pt, | 2518.5 | 11.8 | Gi, |
| | | 2525.5 | 12.1 | Gi, | 2532.4 | 12.2 | Gi, | 2551.8 | 12.5 | Ri. | | | |
| 200212 | SY Aquilæ | 2500.8 | 12.1 | M, | 2524.4 | *11.9* | L, | 2542.7 | *12.2* | Mz. | | | |
| 200357 | S Cygni | 2500.8 | 10.0 | M, | 2502.7 | 10.3 | O, | 2511.9 | 9.8 | Ml, | 2514.7 | 10.7 | Pt, |
| | | 2532.8 | 11.7 | M. | | | | | | | | | |
| 200647 | SV Cygni | 2527.9 | 9.2 | Ri. | | | | | | | | | |

VARIABLE STAR OBSERVATIONS, June 20 to August 20, 1920—Continued.

| Number Name | J.D. Est. Obs. | J.D. Est. Obs. | J.D. Est. Obs. | J.D. Est. Obs. |
|---|---|---|---|---|
| 200715a S Aquilæ | 2493.7 10.4 Mu, | 2498.7 10.4 Ya, | 2500.8 10.8 M, | 2514.7 11.6 Pt, |
| | 2515.5 11.7 Gi, | 2519.6 11.7 B, | 2523.5 11.7 Gi, | 2531.5 11.1 Gi, |
| | 2531.6 10.0 Cl, | 2536.4 10.1 Gi, | 2540.8 9.6 M, | 2546.7 9.6 Pt. |
| 200715b RW Aquilæ | 2493.7 8.9 Mu, | 2498.7 9.3 Po, | 2498.7 9.1 Ya, | 2519.6 9.2 B, |
| | 2531.6 8.7 Cl. | | | |
| 200812 RU Aquilæ | 2500.8 *12.3* M. | | | |
| *200822* W Capricorni | 2522.8 *11.6* M. | | | |
| 200906 Z Aquilæ | 2518.5 8.9 Gi, | 2519.7 9.0 B, | 2522.8 9.1 M, | 2528.4 9.5 Gi, |
| | 2535.4 10.0 Gi. | | | |
| 200916 R Sagittæ | 2498.7 9.1 Ya, | 2531.6 9.0 Cl. | | |
| 200938 RS Cygni | 2467.4 7.8 Ch, | 2482.4 8.2 $Pe_2$, | 2486.2 7.8 Ch, | 2495.2 8.3 Ch, |
| | 2498.3 8.8 Pe, | 2518.6 7.3 Pt, | 2520.4 7.5 L, | 2527.4 7.6 L, |
| | 2532.8 8.0 M, | 2545.8 8.4 M, | 2554.6 7.3 Pt. | |
| 201008 R Delphini | 2527.4 *12.8* L, | 2543.7 13.7 B. | | |
| *201121* RT Capricor. | 2522.6 7.5 Ps, | 2522.8 7.2 M, | 2524.4 6.9 L. | |
| 201130 SX Cygni | 2545.8 *12.9* M. | | | |
| 201437a P Cygni | 2467.4 4.6 Ch, | 2480.4 5.1 Pe, | 2486.2 4.9 Ch, | 2502.4 5.2 Pe. |
| 201647 U Cygni | 2483.4 11.8 Pe, | 2501.6 10.0 Pi, | 2501.6 9.9 Ya, | 2501.8 10.4 M, |
| | 2518.7 10.2 Pt, | 2522.7 10.0 Ps, | 2523.7 10.6 Po, | 2532.8 10.1 M, |
| | 2532.8 *11.1* Ps, | 2546.7 9.8 Pt, | 2556.7 10.3 Ps. | |
| 202539 RW Cygni | 2484.4 8.8 Pe, | 2486.4 9.0 Pe, | 2496.3 8.9 Pe. | |
| 202817 Z Delphini | 2487.5 12.0 Ja, | 2511.7 10.7 O, | 2514.8 10.1 M, | 2518.7 10.1 Pt, |
| | 2521.4 10.2 $Ja_2$, | 2521.8 9.9 M, | 2541.8 9.5 M, | 2547.6 9.5 Pt. |
| 202946 SZ Cygni | 2504.8 9.5 M, | 2523.6 9.7 K, | 2526.6 9.6 Cl, | 2531.6 9.2 Cl, |
| | 2542.6 9.3 Cl. | | | |
| 202954 ST Cygni | 2500.8 10.7 M, | 2501.6 11.0 Pi, | 2514.7 11.5 Pt, | 2532.8 11.9 M. |
| 203226 V Vulpecul. | 2510.7 8.7 O, | 2514.7 8.9 Pt, | 2546.7 8.8 Pt. | |
| 203611 Y Delphini | 2487.5 *12.4* Ja, | 2514.7 *11.1* O, | 2517.4 13.2 Ja. | |
| 203816 S Delphini | 2500.8 9.6 M, | 2514.5 8.9 Cl, | 2514.7 8.8 Po, | 2519.6 8.8 B, |
| | 2523.8 8.7 M, | 2531.6 8.7 Cl, | 2541.8 9.0 M, | 2543.6 8.8 B. |
| 203847 V Cygni | 2467.4 *10.0* Ch, | 2492.2 10.8 Ch, | 2503.7 10.0 M, | 2511.9 9.4 Ml, |
| | 2529.4 8.9 Gi, | 2532.8 10.5 M, | 2535.5 9.1 Gi. | |
| *203905* Y Aquarii | 2515.8 10.5 M. | | | |
| 204016 T Delphini | 2514.7 11.0 Po, | 2523.8 13.8 M, | 2532.6 *11.8* Cl, | 2542.6 *12.0* Cl. |
| *204104* W Aquarii | 2520.4 12.4 L. | | | |
| 204318 V Delphini | 2522.8 *12.5* M. | | | |
| *204405* T Aquarii | 2467.4 *11.0* Ch, | 2515.8 11.1 M, | 2518.7 10.4 Pt, | 2546.7 7.7 Pt. |
| 205030a UX Cygni | 2502.8 11.6 M, | 2547.8 11.3 M. | | |
| 205923 R Vulpec. | 2501.8 9.0 M, | 2510.7 9.2 O, | 2514.7 9.3 Pt, | 2520.5 9.6 Gi, |
| | 2526.7 10.9 Po, | 2530.5 10.9 Gi, | 2536.5 11.2 Gi, | 2545.8 11.8 M. |
| 210382 X Cephei | 2500.8 11.0 M, | 2515.8 11.2 M. | | |
| *210504* RS Aquarii | 2520.4 *12.7* L. | | | |
| 210868 T Cephei | 2467.4 7.9 Ch, | 2492.2 8.6 Ch, | 2499.7 8.5 O, | 2501.6 8.4 Ya, |
| | 2501.8 8.8 M, | 2511.6 9.1 $O_2$, | 2520.7 8.9 Pt, | 2522.4 9.1 L, |
| | 2554.6 10.0 Pt. | | | |
| *210903* RR Aquarii | 2518.8 12.0 M. | | | |
| 213244 W Cygni | 2483.4 6.5 Pe, | 2486.4 5.9 Pe, | 2512.4 5.5 L, | 2523.4 5.6 L. |
| 213678 S Cephei | 2519.8 10.0 M, | 2523.7 10.4 Po, | 2532.8 10.4 M. | |
| 213753 RU Cygni | 2502.8 8.4 M, | 2547.8 8.8 M. | | |

VARIABLE STAR OBSERVATIONS, June 20 to August 20, 1920—Continued.

| Number | Name | J.D. | Est. | Obs. | J.D. | Est. | Obs. | J.D. | Est. | Obs. | J.D. | Est. | Obs. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 213843 | SS Cygni | 2460.3 | 8.4 | Ch, | 2461.2 | 8.2 | Ch, | 2464.2 | 8.4 | Ch, | 2467.4 | 10.1 | Ch, |
| | | 2470.3 | 11.3 | Ch, | 2479.4 | *10.9* | Ja, | 2483.4 | 11.8 | Pe, | 2483.4 | 11.7 | L, |
| | | 2483.4 | 11.5 | Ja, | 2484.4 | 12.0 | Pe, | 2486.4 | 11.9 | Pe, | 2487.4 | 11.8 | Ja, |
| | | 2492.2 | *11.0* | Ch, | 2493.7 | 9.5 | Mu, | 2494.2 | 8.4 | Ch, | 2495.2 | 8.3 | Ch, |
| | | 2496.4 | 8.9 | Pe, | 2497.7 | 8.2 | Pi, | 2498.2 | 8.2 | Ch, | 2498.4 | 8 3 | Pe, |
| | | 2498.6 | 8.2 | Cl, | 2498.7 | 8.3 | Ya, | 2498.7 | 8.3 | Po, | 2499.4 | 8.5 | Pe. |
| | | 2499.6 | 8.5 | K, | 2499.6 | 8.3 | Cl, | 2499.7 | 8.2 | O, | 2499.8 | 8.6 | Pt, |
| | | 2500.3 | 8.3 | Pe, | 2500.6 | 8.3 | Th, | 2500.6 | 8.4 | K, | 2500.8 | 8.6 | Pt, |
| | | 2500.8 | 8.4 | M, | 2501.3 | 8.3 | Pe, | 2501.6 | 8.3 | Cl, | 2501.6 | 8.4 | Ya, |
| | | 2501.6 | 8.2 | O, | 2501.6 | 8.3 | Pi, | 2501.7 | 8.4 | Po, | 2501.8 | 8.4 | M, |
| | | 2502.4 | 8.4 | Pe, | 2502.7 | 8.3 | O, | 2502.8 | 8.5 | M, | 2503.6 | 8.6 | Cl, |
| | | 2503.7 | 8.4 | O, | 2503.7 | 8.6 | M, | 2504.3 | 8.8 | Pe, | 2504.8 | 8.8 | M, |
| | | 2506.8 | 9.6 | M, | 2508.6 | *9.6* | O, | 2509.6 | 10.4 | O. | 2509.8 | 10.5 | M, |
| | | 2510.6 | 10.9 | O, | 2510.7 | 10.9 | Ya, | 2510.8 | 10.7 | M, | 2511.6 | 11.9 | Cl, |
| | | 2511.7 | 11.2 | O, | 2512.4 | 11.4 | L, | 2514.4 | 11.8 | Gi, | 2514.5 | 11.9 | Cl, |
| | | 2514.6 | 11.7 | Pt, | 2514.6 | 11.8 | Gd, | 2514.7 | 11.3 | Po, | 2514.8 | 11.5 | M, |
| | | 2515.5 | 11.8 | Gi, | 2515.6 | 11.7 | Pt, | 2516.4 | 11.8 | Gi, | 2516.4 | 11.1 | Ja, |
| | | 2516.6 | 11.5 | Cl, | 2516.6 | 11.1 | K, | 2517.4 | 11.8 | Gi, | 2517.5 | 11.2 | L, |
| | | 2518.4 | 11.8 | Gi, | 2518.6 | 11.8 | Pt, | 2519.4 | 11.8 | Gi, | 2519.4 | 11.5 | Ja, |
| | | 2519.4 | 11.2 | L, | 2519.6 | *11.0* | Cl, | 2519.6 | 11.3 | K, | 2519.7 | 11.6 | B, |
| | | 2519.7 | 11.8 | Jd, | 2520.4 | 11.8 | Gi, | 2520.4 | 11.4 | L, | 2520 6 | 11.7 | Pt, |
| | | 2521.4 | 11.8 | Gi, | 2521.7 | *11.3* | Po, | 2522.4 | 11.8 | Gi, | 2522.6 | 11.7 | Pt, |
| | | 2522.6 | 11.5 | Cl, | 2522.7 | 11.8 | Jd, | 2522.8 | 11.5 | M, | 2523.4 | 11.3 | Gi, |
| | | 2523.4 | 11.2 | Ja, | 2523.4 | 11.3 | L, | 2523.6 | 11.2 | K, | 2523.6 | 11.2 | Cl, |
| | | 2523.8 | 11.4 | Ri, | 2524.6 | 10.8 | B. | 2525.4 | 10.4 | Gi, | 2525.6 | 10.7 | Pt, |
| | | 2526.4 | 10.4 | Gi, | 2526.5 | 10.8 | Ja, | 2526.6 | 10.9 | Cl, | 2526.6 | 10.7 | Pt. |
| | | 2527.4 | 10.7 | L, | 2527.4 | 10.9 | Gi, | 2527.6 | *10.8* | Cl, | 2529.4 | 11.8 | Gi, |
| | | 2529.4 | 11.1 | L, | 2530.4 | 11.8 | Gi, | 2531.4 | 11.8 | Gi, | 2531.6 | 11.8 | Cl, |
| | | 2531.6 | 11.5 | M, | 2532.5 | 11.8 | Gi, | 2532.6 | *11.2* | Po, | 2532.6 | *11.5* | Cl, |
| | | 2532.8 | 11.4 | Pt, | 2533.5 | *10.9* | Th, | 2533.6 | *10.9* | Cl, | 2534.5 | 11.8 | Gi, |
| | | 2535.5 | 11.8 | Gi, | 2536.5 | 11.6 | Gi, | 2540.6 | *11.8* | Cl, | 2540.6 | 11.9 | Pt, |
| | | 2542.6 | 11.9 | Pt, | 2542.6 | *11.8* | Cl, | 2542.8 | *12.5* | Mz, | 2543.6 | 11.9 | B. |
| | | 2543 6 | 12.1 | Cl, | 2543.6 | 11.9 | Pt, | 2545.6 | 12.0 | M. | 2545.6 | 12.1 | Cl, |
| | | 2546.6 | 11.9 | Pt, | 2547.6 | 11.9 | Pt, | 2550.6 | 11.9 | B. | 2551.6 | 12.0 | B, |
| | | 2554.6 | 11.7 | Pt, | 2554.8 | *11.3* | M, | 2555.6 | 12.0 | Pt. | | | |
| 213937 | RV Cygni | 2504.8 | 7.6 | M. | | | | | | | | | |
| 214024 | RR Pegasi | 2502.8 | *11.4* | M, | 2520.5 | 13.0 | Ja, | 2526.5 | 12.8 | Ja. | 2546.7 | 10.2 | Pt. |
| 215605 | V Pegasi | 2521.8 | *11.9* | M, | 2523.4 | 13.3 | Ja. | | | | | | |
| 215934 | RT Pegasi | 2520.7 | 10.2 | Pt, | 2546.7 | 9.6 | Pt. | | | | | | |
| 220412 | T Pegasi | 2511.9 | 10.5 | Ml, | 2522.8 | 10.9 | M, | 2524.4 | 11.3 | L. | | | |
| 220613 | Y Pegasi | 2519.8 | *12.5* | M, | 2520.5 | 13.0 | Ja, | 2526.5 | 12.9 | Ja. | | | |
| 220714 | RS Pegasi | 2519.8 | 10.8 | M, | 2520.5 | 11.0 | Ja, | 2526.5 | 11.3 | Ja. | | | |
| 222439 | S Lacertae | 2518.5 | 10.9 | Gi, | 2520.5 | 11.0 | L, | 2522 8 | 10.9 | M, | 2527.4 | 11.6 | L, |
| | | 2531.4 | 11.1 | Gi. | | | | | | | | | |
| 223841 | R Lacertae | 2518.5 | *13.7* | Gi, | 2531.4 | *13.7* | Gi. | | | | | | |
| 225914 | RW Pegasi | 2522.8 | 10.6 | M, | 2532.8 | 10.3 | M. | | | | | | |
| 230110 | R Pegasi | 2509.8 | 10.7 | M, | 2520.5 | 12.6 | Ja, | 2526.5 | 12.8 | Ja. | | | |
| 230759 | V Cassiop. | 2499.4 | 11.4 | Pe, | 2499.8 | 11.6 | Pt, | 2523.7 | *11.2* | Po, | 2536.0. | 11.4 | Ml, |
| | | 2547.6 | 11.5 | Pt, | 2551.8 | *12.0* | Bs. | | | | | | |
| 231425 | W Pegasi | 2500.8 | 11.1 | M. | 2519.8 | 11.4 | M, | 2520.5 | 12.2 | Ja, | 2525.5 | 12.0 | L. |
| 233335 | ST Androm. | 2501.8 | 10.2 | M, | 2518.7 | 10.7 | Pt, | 2546.7 | 11.0 | Pt, | 2554.8 | 9.8 | M. |
| *233815* | R Aquarii | 2511.9 | 11.0 | Ml, | 2522.8 | 10.6 | Pt. | | | | | | |
| 233956 | Z Cassiop. | 2510.8 | 9.5 | M. | | | | | | | | | |
| 235053 | RR Cassiop. | 2510.8 | 10.9 | M, | 2554.8 | 11.4 | M, | | | | | | |
| *235209* | V Ceti | 2525.6 | *12.7* | L. | | | | | | | | | |

VARIABLE STAR OBSERVATIONS, June 20 to August 20, 1920—Continued.

| Number | Name | J.D. | Est. | Obs. | J.D. | Est. | Obs. | J.D. | Est. | Obs. | J.D. | Est. | Obs. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 235350 | R Cassiop. | 2501.8 | 8.8 | M, | 2510.8 | 7.8 | M, | 2518.4 | 7.6 | $Gi_2$, | 2530.4 | 7.6 | $Gi_2$, |
| | | 2554.8 | 7.7 | M. | | | | | | | | | |
| 235525 | Z Pegasi | 2518.7 | 8.6 | Pt, | 2520.5 | 8.7 | Ja, | 2522.8 | 8.9 | M, | 2526.5 | 9.0 | Ja, |
| | | 2546.7 | 9.2 | Pt. | | | | | | | | | |
| 235855 | Y Cassiop. | 2510.8 | *11.0* | M. | | | | | | | | | |

| | Observations | Stars | Observers |
|---|---|---|---|
| June 20-July 20 | 777 | | 25 |
| July 20-August 20 | 661 | | 22 |
| Totals, | 1438 | 217 | 32 |

Marquis Nello V. Ginori, of Florence, Italy, resumes observing in his new observatory, known as "Osservatorio di Belmonte." Fr. Luis Rodes is the new Director of the Observatory of Ebro, Tortosa, Spain. Mr. French has returned from the Service, and will have the use of the 11-inch at the Cincinnati Observatory. M. Lacchini, of Faenza, Italy, is also enlarging his equipment.

An attempt is being made to arrange a "get-together" for those members living in the middle west who find it difficult to attend the eastern meetings of the Association. A good many have indicated their interest in this proposal, and through the kindness of Professor Fox, the meeting is to be held at the Dearborn Observatory. All those who are interested in such a meeting of variable star students are invited to correspond with the Recording Secretary, Howard O. Eaton, 428 Lake St., Madison, Wis.

An additional typographical change will be noted in this month's report in that negative observations are indicated by italics. Thus the first observation should be read: On J.D. 2523.7, X Androm. not seen. Less than 15.0. Heretofore such observations have been indicated by prefixing an inequality sign (<) before the faintest visible magnitude.

The following observers contributed to this report: Messrs. Barns, "Bs", Bemporad, "Bp", Brown, "Bn", Bunch, "Bh", Chandra, "Ch", Clement, "Cl", Eaton, "E", Ginori, "Gi", Godfrey, "Gd", Janczewski, "Ja", Jordan, "Jd", Kaster, "Ka", Kimball, "K", Lacchini, "L", McAteer, "M", Menzel, "Mz", Merrill, "Ml", Mundt, "Mu", Murray, "My", Olcott, "O", Peltier, "Pt", de Perrot, "Pe", Peters, "Ps", Pickering, "Pi", Potter, "Po", Rhorer, "Ro", Rich, "Ri", Suter, "Su", Thompson, "Th", Woglom, "Wg", and Yalden, "Ya".

HOWARD O. EATON,
Recording Secretary.

## COMET AND ASTEROID NOTES.

**Tempel's Comet.**—The following position of Tempel's Comet has been received here.

| G.M.T. | R.A. | DEC. | OBSERVER. | PLACE. |
|---|---|---|---|---|
| July 20.8293 | $1^h\ 53^m\ 24^s.7$ | $-1°\ 17'\ 23''$ | Van Biesbroeck | Yerkes Observatory |

The comet is described as round, and of ninth magnitude.

Harvard College Observatory Bulletin 726. S. I. BAILEY.
Cambridge, Mass., U. S. A., July 22, 1920.

**Comet Tempel II.**—The cable message and telegrams, sent out by this Observatory on May 28, in regard to the observation of Comet Tempel II by Kudara of Kyoto, as well as H.B. 719, contained an error of two hours in right ascension. The cablegram from Kudara, as received here, read "twenty hours fifty-five minutes seven," but a letter of the same date from him, received much later, gave $22^h\ 55^m\ 43^s.7$. It appears, therefore, that a mistake of two hours was made by the cable service, probably by the omission of the word "two" from the message, which was not in code.

Dr. Kudara sends the following revised elements, based chiefly on Maubant's elements, with the remark that they will probably give positions a little behind actual places.

ELEMENTS.

| | | |
|---|---|---|
| Time of perihelion passage | (T) = | 1920, June 10.196 G.M.T. |
| Perihelion minus node | ($\omega$) = | 186° 39′ 00″ |
| Longitude of node | ($\Omega$) = | 120° 46′ 05″ 1920.0 |
| Inclination | (i) = | 12° 45′ 14″ |
| Angle of eccentricity | ($\phi$) = | 33° 54′ 21″ |
| Mean daily motion | ($\mu$) = | 687″.51 |
| Perihelion distance | (q) = | 1.32 |
| | log $a$ = | 0.47515 |

The following positions of Comet Tempel II have been received here.

| G.M.T. | R.A. (h m s) | Dec. (° ′ ″) | Observer. | Place. |
|---|---|---|---|---|
| July 21.8845 | 1 55 56.07 | −1 19 38.7 | Van Biesbroeck. | Yerkes Observatory |
| July 22.8226 | 1 58 9.17 | −1 21 36.0 | Van Biesbroeck. | Yerkes Observatory |
| July 24.8611 | 2 2 50.56 | −1 26 50.0 | Van Biesbroeck. | Yerkes Observatory |
| July 27.8618 | 2 9 27.12 | −1 36 16.9 | Van Biesbroeck. | Yerkes Observatory |
| Aug. 8.667 | 2 37 23. | −2 55 43. | C. H. Hall, Jr. | Baltimore |

The total magnitude of the comet was estimated as 10 on July 27.

S. I. BAILEY.

Harvard College Observatory Bulletin 728.
Cambridge, Mass., U. S. A., August 11, 1920.

**Elliptic Elements of Borrelly's Comet (1905 II).**— On the first page of the July 19, 1920 (No. 773) number of the *Astronomical Journal* are some observed positions of Borrelly's (1905 II) comet by M. P. Chofardet of Besancon, France. From the three observations of Oct. 9, 1918, Dec. 6, 1918 and Feb. 4, 1919, I have computed elliptic elements and constants as given below:

ELEMENTS.

Epoch 1918, December 6.3802 G.M.T.

| | | | | | |
|---|---|---|---|---|---|
| $M$ = | 2° | 47′ | 12″.18 | log $e$ = | 9.788886 |
| $\omega$ = | 352 | 23 | 32.45 | log $a$ = | 0.559350 |
| $\pi$ = | 69 | 20 | 34.74 | log $q$ = | 0.144792 |
| $\Omega$ = | 76 | 57 | 02.29 | $\mu$ = | 514″.023 |
| $i$ = | 30 | 29 | 13.54 | | |

CONSTANTS.

$x = r\,[9.939182]\ \sin\ (164°\ 56′\ 45″.21 + v)$
$y = r\,[9.951352]\ \sin\ (\ 91\ \ 29\ \ 55.63 + v)$
$z = r\,[9.824174]\ \sin\ (\ 35\ \ 31\ \ 47.99 + v)$

FRANK E. SEAGRAVE.

Boston, Sept. 7, 1920.

## COMMUNICATIONS

**A Lunar Crater on the Earth.**—The extinct volcano, Haleakalá, is on the island of Mani, one of the Hawaiian group. It is a rock mountain 10,000 feet high, having on its summit an oval-shaped crater, 7 by 3 miles. This crater has a level sand floor which is surrounded by a jagged rim averaging about 500 feet above the floor. Consulting a Standard Encyclopedia, I learn that the crater is from 700 to 2,000 feet deep, which shows that "information" from such sources is not always accurate. The remarkable features of the volcano are the typical lunar cones which exist within the crater near the center.

I have climbed numerous volcanoes, active and extinct, in various parts of the world, but I have nowhere else seen those lunar formations. If a photograph of Haleakalá, taken from an airplane or the moon were shown to a selenographer, he would unhesitatingly pronounce it a lunar crater. We have therefore at least one typical lunar crater on the earth and perhaps this is the only one.

Near the centre is a steep sand cone about 200 feet high, with several smaller cones ranging from 30 to 100 feet.

I spent a night in the crater, with a companion, in the year 1889. Neither we nor our horses slept on account of the biting cold and the biting sand fleas. The whole floor of the crater, which is composed of coarse wet sand, from the surface to a depth of a foot, literally swarms with huge fleas—larger than any dog fleas. The top of the mountain is bare rock without a trace of any vegetable or animal life, and the same is true of the crater with the exception of the fleas. On what do these countless billions subsist? This might be worth the study of some naturalist.

The last eruption of Haleakalá was prehistoric and I cannot understand how these steep cones of loose sand—albeit wet sand—have remained standing through the ages.

Query: Are not the identical formations in the moon likewise cones of loose sand?

F. J. B. Cordeiro.

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**Theories Relating to Aurorae.**—Though the Aurorae Borealis and Australis are known to be caused by electrical action, the manner in which these phenomena are produced is still a matter of dispute and uncertainty. It has been definitely settled by observation that the auroral phenomena are the direct products of "storms" on the sun. This has brought forth the theory that, as a result of disintegrating explosions of atoms in the sun forming the prominences in the corona of that body, this explosion, if sufficiently strong, will throw its final atoms (electrified hydrogen and possibly helium) to the earth. An example of this can be found in the instance that during the total solar eclipse of May 28-29, 1919, a large prominence was observed and that on June 1, 1919, a rather spectacular Aurora was seen in various parts of the United States. The time elapsing between the appearance of the eruption and the Aurora is usually about 45 hours, the electrified hydrogen and helium traveling about 575 miles per hour —somewhat in excess of the upward movement of the gases in some great prominences (probably due to the lack of resisting gases). In the case just mentioned the author predicted the phenomenon some 24 hours in advance.

As explanation of the various colors observed, it has been stated that by filling a tube with a gas, reducing the pressure sufficiently to create conditions

similar to those at the height where Aurorae occur, and then passing an electric current through the tube a color—red, green, etc., (varying with the gas used) may be obtained, similar to those exhibited during Aurora displays. Neon gives the red and pink colors, crypton the greenish tints and other elements give their characteristic colors.

It is advanced by some that, to be successfully bombarded by corona streamers, the earth must be at or near one of its equinoxes. I would refer these to the case previously cited, the sun was at that time approaching its summer solstice. They might also be referred to the long arctic nights where Aurorae may be expected almost any time.

Yet, the supporters of this belief have some substantiation in the fact that the extraordinary Aurora of March 22, last, observed throughout the country, occurred at the vernal equinox and was caused by a group of small sunspots which might not have been capable of producing such a wonderful display had the sun been at one of its solstices. They might also count in their behalf the fact that more Aurorae occur with the earth near one of is equinoxes and near its perihelion than at other times.

These various theories shall prove themselves in the course of a series of observations and experiments. Time will tell.

Chestertown, Maryland. H. WILLARD CULP.

## GENERAL NOTES.

**Dr. Herbert C. Wilson** has been relieved for the present college year of his duties as Professor of Mathematics and Astronomy in Carleton College and Editor of POPULAR ASTRONOMY. Dr. Wilson, Mrs. Wilson, and daughter Lois left early in September for Los Angeles, where they will spend the winter. Dr. Wilson will be engaged for a part of the time in research work at the Mt. Wilson Observatory.

**Dr. Edward A. Fath,** formerly of the Mt. Wilson Observatory, and later Professor of Astronomy in Beloit College, has accepted a position as Professor of Mathematics and Astronomy in Carleton College, and began his duties there with the opening of the college year. Dr. Fath will also be associated with the editorial work of POPULAR ASTRONOMY.

**Dr. Frederick Slocum,** who resigned the directorship of the Van Vleck Observatory, Wesleyan University, to take charge during the war of the School of Navigation at Brown University, has been reappointed director of the Van Vleck Observatory, and will resume his duties there in the fall. During the summer Dr. Slocum has been associated with Dr. L. A. Bauer in discussing observations made on the non-magnetic vessel "Carnegie," bearing on the subject of terrestrial magnetism.

**Karl Hermann Struve,** director of the Berlin-Babelsberg Observatory, Professor of Astronomy in the University of Berlin, and member of the Prussian Academy of Sciences, died on August 12 at Herrenalb.

**Sir Norman Lockyer.**—We record with deep regret the death, on August 16, at the age of 84, of Sir Norman Lockyer, K.C.B., F.R.S. (*The Observatory*, September, 1920.)

**Mr. Eric Doolittle.**—A brief mention of the death of Dr. Eric Doolittle, director of the Flower Observatory of the University of Pennsylvania, was made in the newspapers just as we were going to press. An account of his life and work will be published in a coming number.

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**Professor Giovanni Celoria,** Director of the Milan (Italy) Observatory, died on August 17, 1920, at the age of 78. Professor Celoria is the third of three Italian astronomers of note who have died within a year, the other two being Ricco of Catania and Millosevich of Rome.

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**Mrs. Fiammetta Wilson,** the well known English observer, died on July 21, 1920. Mrs. Wilson was especially active in the observation of aurorae, zodiacal light, and meteors. In meteor observations she was associated with Mr. W. F. Denning. "The Observatory" states that she and Mr. Denning "obtained together more duplicate paths (accordances) of meteors than has ever been known in the history of meteoric astronomy." Mrs. Wilson was a Fellow of the Royal Astronomical Society, a member of the Leeds Astronomical Society, the Société Astronomique de France, the Société d' Astronomie d' Anvers, and the Commission des Etoiles Filantes. She had been awarded by the Harvard College Observatory the "Edward C. Pickering Astronomical Fellowship for Women" for the year 1920-21, but unfortunately her death occurred before the news of this award reached her.

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**Mr. Carl Stearns,** instructor in astronomy at Wesleyan University, has been appointed assistant at the Yale Observatory.

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**The "William Ellery Hale Fund"** has presented to the Royal Observatory of Arcetri, of which Antonio Abetti is the Director, the sum of 36,900 Italian lire to help in the construction of a 60-foot tower telescope there.

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**The Galileo Medal** (Medaglia Galilejano) has been awarded by the "Royal Instuto di Studi Superiori" of Florence to Professor George E. Hale, Director of the Mt. Wilson Observatory.

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**Professor O. M. Leland,** until recently Professor of Geodesy and Astronomy and Head of the Department of Topographic and Geodetic Engineering at Cornell University, has been elected to the deanship of Engineering, Architecture, and Chemistry at the University of Minnesota.

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**February and Full Moons.**—Mr. Samuel G. Barton has called attention to the fact that in the note on page 439 of the August-September number, "When February has no full moon," the longitude for which the facts as stated apply should have been given. Doubtless the statements were made with reference to the longitude of Greenwich. Mr. Barton states that in 1893 there was no full moon in February in the United States, although there was one in England, civil dates being used.

Mr. Barton adds: "It may be of interest to note that when February has five Sundays, as it did this year, three legal holidays, Washington's Birthday, Memorial Day, and Independence Day fall on Sunday. Under no other circumstances can more than two legal holidays fall on Sunday."

**New Star Discovered in the Constellation Cygnus.**—On August 20, a new star was discovered in the constellation Cygnus by Mr. W. F. Denning of Bristol, England, while he was engaged in observing meteors. This "Nova", although not nearly so bright at maximum as Nova Aquilae No. 3 in June, 1918, was bright enough to be noticed by several persons independently, among them Mr. L. C. Peltier, Delphos, Ohio, on August 22, and S. Kanda, Tokyo, Japan, on August 22, the earliest observation, however, being by Mr. Denning.

Mr. Denning's letter concerning the discovery, published in *The Observatory* for September 1920, is as follows:

GENTLEMEN,—

Since I had the honour of being one of the independent discoverers of Nova Aquila (1918) I have, while watching for meteors, pursued the work of searching for new stars also. On Aug. 20 the night was very clear, and at 9:30 G.M.T. I noticed a star in Cygnus (of about 3½ mag.) which I could not remember to have seen before, though the positions of the great majority of naked-eye stars in the N. hemisphere are familiar to me. I obtained the rough place of the suspected object as R.A. 299° Dec. N. 53½°, and on reference to my celestial globe, atlases, and catalogues quite failed to identify the star—in fact, the position I assigned to it seemed vacant on the charts etc. I consulted. I therefore concluded it to be a nova, and notified the Astronomer Royal and Prof. Turner by means of telegrams and postcards.

On the previous night, Aug. 19, I had been observing the same region for 2 hours ($10^h$ to $12^h$ G.M.T.), but saw nothing of any strange object. The night was not good, however; the stars were slightly dimmed by mist, and I might easily have overlooked the nova had it been fainter than mag. 4.

The brightness of the nova has shown considerable increase since the night of discovery, my observations being as under:—

| | | |
|---|---|---|
| Aug. 20 . . . | mag. 3.5. | Sky clear. |
| Aug. 21 . . . . | mag. 3.3. | Seen only through openings in swiftly passing clouds and value doubtful |
| Aug. 22 . . . . | mag. 2.8. | Sky pretty clear. |
| Aug. 23 . . . . | mag. 2.2. | Sky quite clear at times. (Mean of 3 observations during the night.) |

Aug. 24 was overcast and not a star visible.

I presume that, as new stars appeared in Cygnus in 1600 (Jansen) and in 1876 (Schmidt), the present nova will be called Nova Cygni III.

I am, Gentlemen,
Yours faithfully,
W. F. DENNING.

Bristol, 1920, Aug. 25.

P.S.—Aug. 25 $8^h$ G.M.T. The nova shone out in a blue interval between broken clouds, and I saw that it had much declined in light since the last observation on August 23.

The star has remained visible to the naked eye from the time of its discovery until the present time (September 18), although it is gradually becoming fainter. It is therefore a typical nova in this respect.

Its position as determined by Fischer-Petersen is, R.A. $19^h\ 56^m\ 28^s.1$, Dec. $+53°\ 24'\ 27''$. It is therefore in the region of the Milky Way, as has been true of nearly all of the past novae. It forms a small triangle, approximately isosceles, with the naked eye stars $\psi$ and $d$ (20) Cygni.

The *Harvard College Observatory Bulletin*, No 729, comments as follows:

An examination of the Harvard photographs by Miss Leavitt shows that on two plates taken with a 1-inch Cooke lens on August 9, the nova was not visible and must have been fainter than the magnitude 9.5. One of these plates was examined August 11, and the other August 14, by Miss A. D. Walker, in accordance with the

systematic plan for keeping the Milky Way under regular observation. Cloudy weather prevented the securing of more photographs of this region until August 19, when a plate was taken with a ½-inch Voigtländer lens, at $13^h\ 20^m$, G.M.T. The nova was present, and of about the magnitude 4.8. The next night, August 20, it was photographed on four plates, which show it much brighter, of about the third magnitude.

A chart of the region, showing comparison stars with their visual magnitudes, is being prepared and will be sent to any one who desires to observe the nova.

Mr. S. Kanda has sent us the following note concerning his observations of the nova.

In the course of observing meteors, I found a nova near $\psi$ Cygni on the evening of August 22, at $1^h\ 35^m$ G.M.T. at Shimo-Shibuya near Tokyo. I have secured the following observations of its magnitude (Harvard Scale).

| Date | G.M.T. | | S. Kanda | K. Kanda | Remarks |
|---|---|---|---|---|---|
| Aug. 22 | $3^h$ | $15^m$ | 2.65 | 2.60 | |
| 22 | 23 | 20 | 2.33 | 2.43 | |
| 23 | 3 | 0 | — | 2.10 | |
| 24 | 0 | 0 | 1.85 | 1.77 | |
| 24 | 22 | 35 | 2.15 | 2.19 | Cloudy. |
| 26 | 0 | 0 | 2.03 | 1.98 | Cloudy. |
| 28 | 5 | 35 | 2.76 | 2.91 | Cloudy. |
| 29 | 4 | 10 | 3.22* | 3.30* | Cloudy. |
| 29 | 22 | 30 | 3.72 | 3.83* | |
| 30 | 22 | 5 | 3.70* | 3.77* | |
| 31 | 22 | 50 | 3.65* | 3.57* | Cloudy. |
| Sept. 1 | 22 | 30 | 3.83* | 3.82* | |

* With binoculars, the others with naked eye.

Tokyo Astronomical Observatory, Sept. 3, 1920.

The nova has been observed at Goodsell Observatory both visually and photographically at various times. We are planning to publish in the next issue a photograph of the region showing the change in brightness of the nova.

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**Nantucket Maria Mitchell Association.**—The New Library Building of the Nantucket Maria Mitchell Association, opposite the Memorial House and Observatory, on Vestal Street, Nantucket, Mass., was dedicated July 15.

This is a Scientific Library free to all interested in astronomy or any of the Natural Sciences. It is hoped that the increased space for books will enable us to meet all demands of Nature Lovers.

The Library is open: 10 to 12 A. M. and 2 to 5 P. M. from June 15 to September 15 each year—and during the winter, two afternoons of each week from 2 to 4.

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**The National Research Council,** with headquarters at Washington, has elected the following chairmen of its various divisions for the year beginning July 1, 1920:

Division of Foreign Relations, George E. Hale, Director, Mt. Wilson Observatory, Carnegie Institution of Washington; Government Division, Charles D. Walcott, Secretary of the Smithsonian Institution, and President of the National Academy of Sciences; Division of States Relations, John C. Merriam, Professor of Palaeontology, University of California and President-elect of the Carnegie Institution of Washington; Division of Educational Relations, Vernon Kellogg, Professor of Entomology, Stanford University and Permanent Secretary of the

National Research Council; Division of Industrial Relations, Harrison E. Howe; Research Information Service, Robert M. Yerkes; Division of Physical Sciences, Augustus Trowbridge, Professor of Physics, Princeton University; Division of Engineering, Comfort A. Adams, Lawrence Professor of Engineering, Harvard University; Division of Chemistry and Chemical Technology, Frederick G. Cottrell, Director of the Bureau of Mines; Division of Geology and Geography, E. B. Mathews, Professor of Minerology and Petrography, Johns Hopkins University; Division of Medical Sciences, George W. McCoy, Director of the U. S. Hygienic Laboratory since 1915; Division of Biology and Agriculture, C. E. McClung, Professor of Zoology, University of Pennsylvania; and Division of Anthropology and Psychology, Clark Wissler, Curator of Anthropology, American Museum of Natural History, New York.

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**UNRECORDED.**

Hast thou, O Time, within thy archives old
A record of that conversation great
When Galileo and young Milton sate
Bright face to face and did their dreams unfold?
Thou hast it not; their speech no scribe hath told
Yet we do know they spake, with souls elate,
Of new-found worlds, of stars and of that state
Wherein the Muse her empery doth hold.
For both were poets, both astronomers,
And each the other well could understand;
Their souls were brothers, kin to starry things,
And each to high imagination stirs
The mind—as though the brow a magic wand
Had touched, or else the tips of unseen wings. —C.G.B.

From the *Chicago Tribune*, Sept. 9, 1920.